DOE/EA-0182

ENVIRONMENTAL ASSESSMENT

Y-12 PLANT SITE

OAK RIDGE, TENNESSEE

DECEMBER 1982

U.S. DEPARTMENT OF ENERGY

OFFICE OF MILITARY APPLICATION

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SUMMARY

The Oak Ridge Y-12 Plant, operated by Union Carbide Corporation, Nuclear Division, under contract to the U.S. Department of Energy (DOE), has five major responsibilities:

- production of nuclear weapons components
- fabrication support for weapon design agencies
- support for other UCC-ND installations
- support and assistance to other government agencies
- processing of source and special nuclear materials

This Environmental Assessment describes the ongoing operations of Y-12 and evaluates the actual and possible impacts on the environment that continuation of these operations entails. Transportation operations external to the Y-12 Plant are not addressed in this document. Since the plant predates the National Environmental Policy Act of 1969 (NEPA) by over two decades, there previously has been no overall formal retrospective environmental assessment of the whole of its facilities and operations.

Y-12 is located on the DOE Oak Ridge Reservation adjacent to the city of Oak Ridge, Tennessee. The plant and auxiliary facilities occupy 1,384 ha (3,420 acres). It includes approximately 300 buildings plus several disposal sites. These include Rogers and Kerr Hollow Quarries and the sanitary landfill.

Y-12 is located within the Great Valley of the Tennessee River. The plant is situated in Bear Creek Valley at the eastern boundary of the Oak Ridge Reservation. Altitudes range from 226 m (741 ft) to 413 m (1,356 ft) for the subparallel ridges and valleys. Geologic formations are of sedimentary origin. The resultant soils are primarily not suitable for agricultural practice on Y-12 property even though the surrounding region is agrarian in nature. Y-12 is a primary employer in the manufacturing sector of the area.

Y-12 is within the Clinch River drainage system. Two streams are associated with Y-12 operations: the East Fork Poplar Creek and Bear Creek. Each stream has received Y-12 effluent discharges, among others, and has experienced moderate pollution. Accidental discharges of polychlorinated biphenyls (PCB) and mercury have occurred in the past. However, critical concentrations have not been recorded in the water, sediments, or biota. The Plant currently meets National Pollutant Discharge Elimination System (NPDES) permit requirements. No flooding has occurred at the Y-12 Plant.

Humid continental climate characterizes the area with mild winters and hot summers being the norm. Precipitation is evenly distributed throughout the year. Low-level inversions are frequent and fall is usually the season with the greatest number. Because of this air stagnation potential, air pollution is a real concern. Although the Y-12 Plant area meets national ambient standards, sulfur dioxide and particulate emissions have, in the

past, exceeded source emission concentrations. Y-12 has rectified the sulfur dioxide problem by switching to low sulfur coal as the primary fuel source at the steam generation plant. Funding has also been approved to provide facilities at the steam generation plant to reduce particulate emissions.

Biota characteristic of the Appalachian oak forest region are abundant. Most frequent dominant tree species include northern red oak, chestnut oak, and yellow poplar. Representative animals include whitetail deer, fox squirrel, pine vole, cotton mouse, and opossum. No threatened or rare plants are known on Y-12 facilities. Although endangered animals exist on the reservation, none have been reported on the Y-12 industrial facilities and, hence, the probability of impact is negligible.

No archaeological sites or historic properties are located on Y-12 lands.

Alternatives considered in this assessment are:

1. No Action - Continued operation of the Y-12 Plant with limitation of adverse impacts by improved pollution control technologies (e.g., waste treatment) as they become available. No plant expansion is scheduled.

2. Discontinue Y-12 Plant operations.

3. Relocate Y-12 Plant operations.

4. Reduce Y-12 Plant operations.

Only the preferred action of continued operation is viable. The other alternatives either only shift environmental impacts to other areas or represent unrealistic solutions.

Impacts from releases of radioactivity to the atmosphere from routine operations were found to be minimal. A small probability exists for accidental releases of radioactivity. A conservative evaluation of an accident involving a fire in a filtering system in a facility processing enriched uranium showed that the release of five kilograms of enriched uranium would expose individuals residing one-half mile north of the plant to 0.02 rem or 13 percent of the exposure to the general public permitted by DOE standards.

Releases of nonradioactive chemicals would have some impacts on the environment. These impacts, however, are not believed to be injurious to the general public. Due to the variety of chemicals used in the plant, several accidental releases were postulated. Atmospheric releases involving a fire in a building which contains significant quantities of mercury and a release of hydrogen fluoride as the result of a cylinder valve breakage were evaluated. In both cases, concentrations of these materials were calculated at the closest residences which exceeded exposure standards but were below levels considered by OSHA to be immediately hazardous to life and health. An accident involving spillage of acid during a transfer operation was found to do temporary damage to the ecosystem in the stream draining the plant area.

Impacts from the continued operations are minimal or negligible for land use, meteorology (air quality), biology, hydrology, and archaeology. Y-12 is an integral contributor to Oak Ridge's economy and any change will have a profound effect on the community. The only major area of environmental concern involves particulate emissions from the Y-12 steam generation plant. Therefore, funding has been approved for the installation of pollution abatement equipment, i.e., baghouses, be installed to reduce particulate emissions. Despite current compliance with permits, regulations, and standards for effluent and surface stream water quality, improved environmental control is recommended for surface water discharge, wastewater treatment, PCB disposal, and coal storage. Some of these improvements are currently under consideration or are being implemented.

Due to unforeseen delays in the completion of this report, much of the data presented is several years old. However, since conditions in the Oak Ridge area and the Y-12 Plant have not changed significantly in this period, the data presented is typical of present conditions.

I
PURPOSE AND NEED FOR THE PROPOSED ACTION

The Oak Ridge Y-12 Plant is one of the U.S. Department of Energy's major installations in Oak Ridge, Tennessee. The facility, which is operated by Union Carbide Corporation, Nuclear Division, Oak Ridge, is basically a production facility for nuclear weapons components; however, a portion of the total facility is used by the Oak Ridge National Laboratory for execution of physical and biological research.

Major activities at Y-12 include chemical processing of lithium and uranium compounds, precision fabrication of components from lithium, uranium, and many other materials, and the assembly of these components into major subassemblies for nuclear weapons. ORNL research activities at Y-12 include fusion, fission reactor development and safety, and biological studies on the impact of radiation on living organisms.

Y-12 is located in Oak Ridge, Tennessee (Figure I-1). The Y-12 Plant site (Figure I-2) contains a total of 1,384 ha (3,420 acres) consisting of an inner industrial plant complex covering 243 ha (600 acres) surrounded by a required buffer area of approximately 1,141 ha (2,820 acres). The industrial plant complex is roughly divided into two portions, the western portion being devoted to DOE ongoing weapons-manufacturing activities and the eastern portion being devoted to DOE-Oak Ridge National Laboratory (ORNL) primary research programs in biology, reactor, controlled thermonuclear, and stable isotope separation activities. The plant facilities include 261 buildings, including large machine shops, chemical processing buildings, laboratories, maintenance buildings, change houses, and numerous plant support facilities. Within the surrounding buffer area and outside the main industrial complex, approximately 2.2 ha (5.5 acres) are allocated to a retention pond for fly ash and bottom ash pumped through a pipeline from the Y-12 steam plant. A fenced area is located on Bethel Valley Road immediately south of the plant containing approximately 12 ha (30 acres) surrounding a former quarry (Bethel Valley Quarry) which was formerly used as a disposal site for non-radioactive obsolete classified tools and equipment; it is now used as an overflow and dilution basin receiving the outflow from the Y-12 ash-retention pond. Approximately 51 ha (125 acres) are allotted for a sanitary water-treatment plant which serves the Y-12 Plant, the ORNL, and the City of Oak Ridge. This treatment facility is operated by another DOE prime contractor, Rust Engineering Company. Portions of the buffer area also are used for other DOE programs administered by ORNL involving approximately 567 ha (1,400 acres) for environmental research and forestry management and for programs administered by the Comparative Animal Research Laboratory (CARL) involving approximately 243 ha (600 acres). Approximately 5 km (3 mi) of the extreme eastern end of Bear Creek Road on the north side of the industrial complex also passes through the buffer area. Plant support areas outside the buffer area (Figure I-2) include approximately 61 ha (150 acres) for a sanitary waste landfill used to dispose of solid wastes from the Y-12 Plant, ORNL, and Oak Ridge Gaseous Diffusion Plant (ORGDP); approximately 26 ha (65 acres) located west of the main plant used as a burial ground for low level radioactively contaminated solid wastes generated in Y-12 Plant operations;

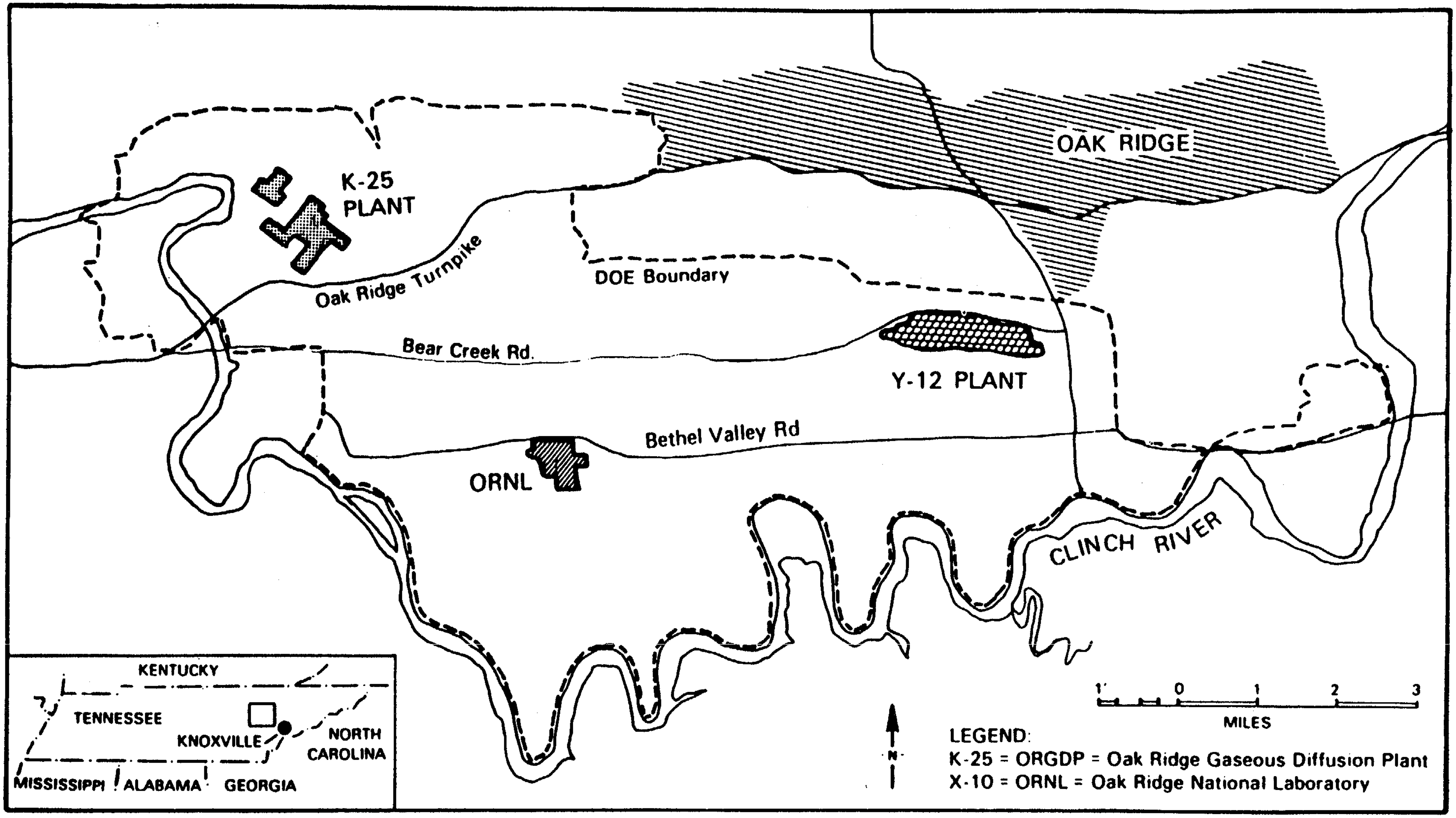

FIGURE I-1. U.S. DEPARTMENT OF ENERGY OAK RIDGE RESERVATION, SHOWING THE THREE PLANTS (K-25, X-10, Y-12) AND THE CITY OF OAK RIDGE

Source: Alexander, 1979.

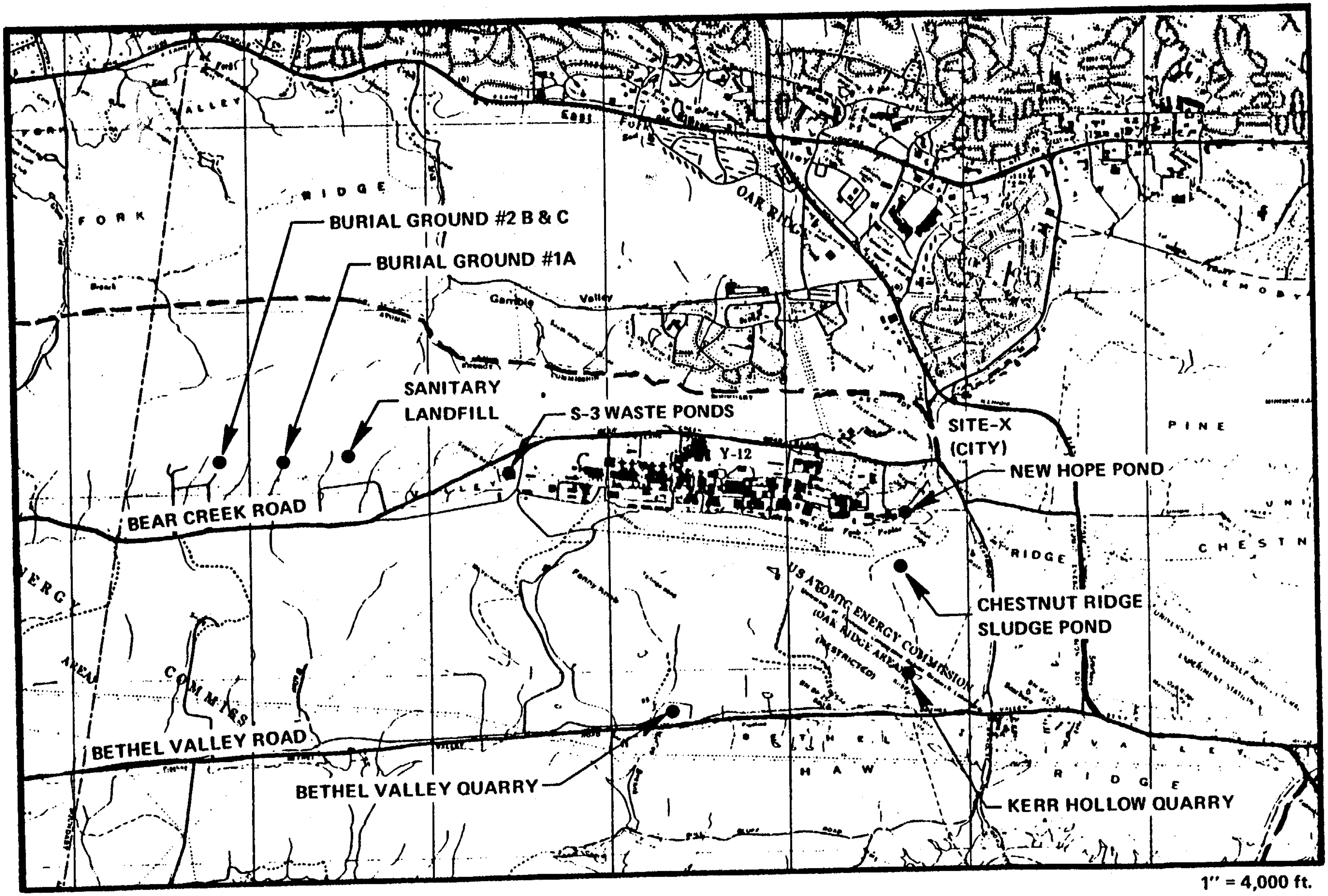

FIGURE I-2. WASTE MANAGEMENT AREAS WITHIN THE OAK RIDGE NATIONAL RESERVATION

Source: Oak Ridge Operations, 1975.

an approximately 1.6-ha (4-acre) site, Kerr Hollow Quarry, comprising an abandoned quarry filled with water located north of Bethel Valley Road and approximately 610 m (2,000 ft) west of the intersection of Bethel Valley and Scarboro Roads which was formerly used as a disposal and dilution basin for selected non-radioactive chemical wastes, primarily sodium, lithium, and potassium, obtained from Y-12 Plant operations; and a .4-ha (1-acre) site located on the north bank of Melton Hill Lake at Clinch River, Kilometer 66.8 (Mile 41.5), for a pumping station which supplies raw water to the Y-12 Plant and the Oak Ridge water plant.

The proposed action is actually a no action alternative because it calls for the continued operation of the existing Y-12 facility. This action is essential to the maintenance of the United States' national defense program. Also, essential research and development activities are conducted in nuclear energy and alternative energy sources. Radiation risk to man is another principal research area. Other benefits for the Y-12 operations include machining capabilities which have become a resource for other government agencies and technology spinoffs to industry of non-classified items under DOE patents. In addition, unclassified information is made available to the interested public.

Literature Cited

Alexander, J. K. 1979. Background environmental information--Y-12 Plant. Report No. ORO-771. U.S. Department of Energy, Oak Ridge, TN.

Oak Ridge Operations. 1975. Oak Ridge Land Use Plan. Report No. ORO-748. U.S. Energy Research and Development Administration, Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee.

II
ALTERNATIVES

II.A ACTIONS CONSIDERED

II.A.1 Proposed Action - The No Action Alternative

The action proposed is the no action alternative whereby the existing Y-12 Plant will continue its current operation to meet the responsibilities described in Section I. Existing operations involve resource utilization and disposal of wastes created in performing these functions.

The Y-12 Plant has conducted an extensive environmental sampling program for over 25 years. This environmental monitoring program currently involves sampling and analyzing air, water from surface streams, several food products, the flora, and soil. These data have been used to determine general environmental conditions and to address the impacts of present Y-12 operations. Discussion of these general topics is presented in the appropriate sections (cf., Sections III and IV). Specific topics developed herein concern energy use, water consumption, and the fate of gaseous, liquid, and solid wastes.

Y-12 shares natural gas, oil, and electricity sources with all of Oak Ridge. Coal is contracted independently by Y-12. Since 1975, Y-12 has striven to reduce its total energy consumption. Total energy used at the installation per fiscal year expressed in British Thermal Units (BTU) is as follows: 1975, 8818×10^9; 1977, 9108×10^9; 1978, 8598×10^9; 1979 8587×10^9 (Union Carbide, 1979a).

Electricity is supplied to Y-12 by the Tennessee Valley Authority (TVA). Electric consumption has been reduced the last several years by 9 percent (Figure II-1). This has been achieved by the reduction of nonessential lighting and the shutting down of utilities equipment on off-shifts, weekends, and holidays (Union Carbide, 1979a).

Since 1975, the plant has stopped using natural gas as boiler fuel. This was due to gas shortages in the area. Peak demands and limited supply resulted in curtailment of natural gas to Y-12 and the subsequent allocation of supplies to higher priority gas users. Rather than depend upon oil, Y-12 has switched to coal as the primary energy source for its steam boilers (Figure II-1). The use of coal has led to increased particulate emissions from the boilers, the generation of fugitive emissions from the coal piles, and the discharge of leachates from the coal piles.

Water is supplied from a DOE-owned treatment facility located on Pine Ridge just north of the plant. Y-12 uses about 908.4 million liters (240 million gallons) of treated water per month. Raw water is available from the Clinch River pumping station. Annual consumption of raw water is around 3,270 million liters (864 million gallons) (Alexander, 1979).

Many types of wastes and potential pollutants are generated as the plant operations are carried out. These include low level radioactive wastes from the plant operations involving the processing and fabrication of

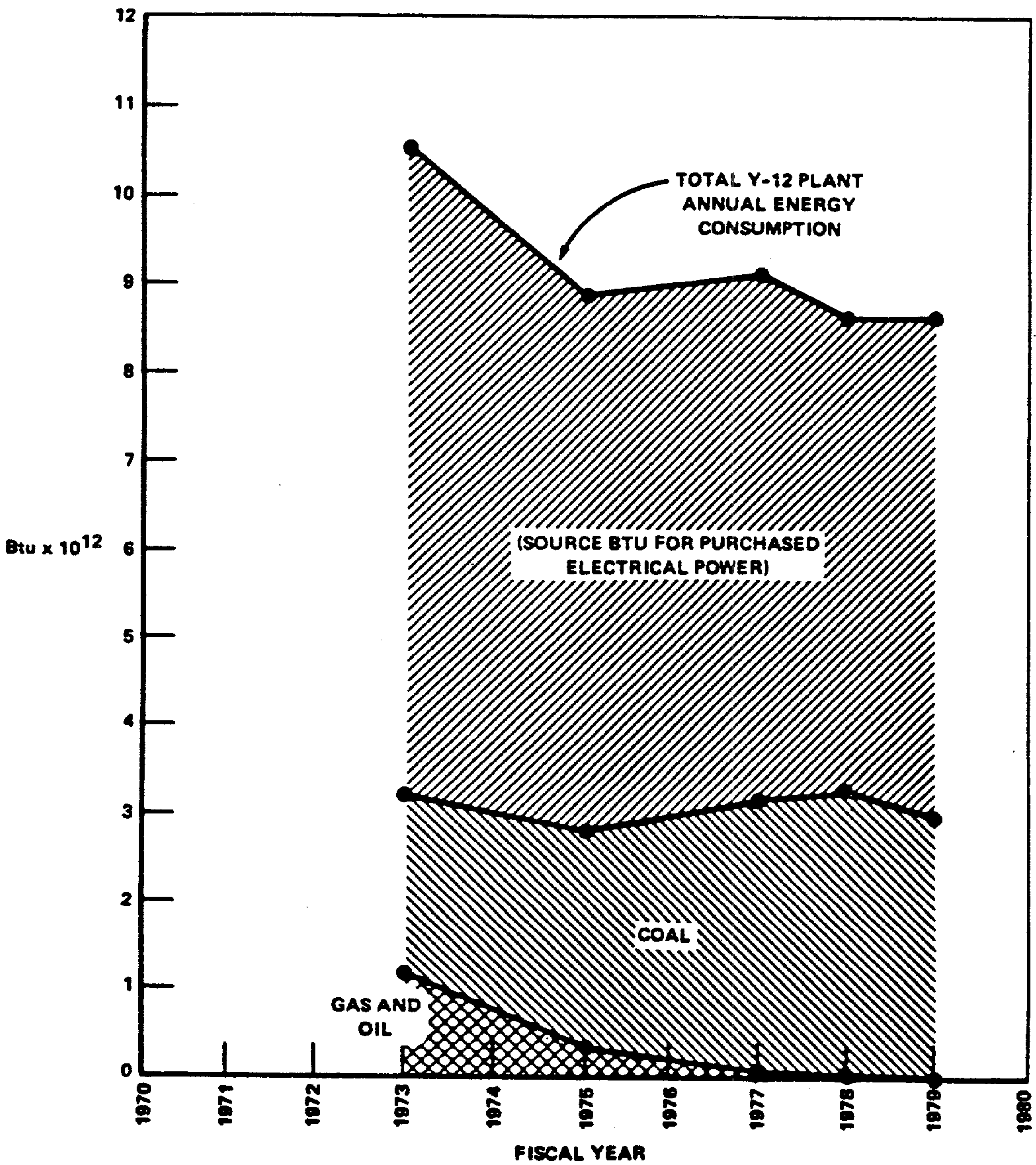

FIGURE II-1. ENERGY CONSUMPTION

Source: Union Carbide, 1979a

uranium and other radioactive materials. Nonradioactive wastes and potential pollutants are generated from support operations such as:

- acid disposal
- air conditioning
- cooling towers
- steam plant operations
- water demineralizers.

A schematic diagram of the effluents, emissions, and wastes produced at the Y-12 Plant is shown in Figure II-2. This diagram includes the types of wastes and potential pollutants, their disposal sites, and points of entry into the various environmental media.

As shown in Figure II-2, nonradioactive solid wastes are buried in a centralized sanitary landfill or designated burial areas. Radioactive solid wastes are buried in designated burial areas or placed in retrievable storage either above or below ground, depending upon the type and quantity of radioactive material present and the economic value involved.

Gaseous wastes usually are treated by filtration, electrostatic precipitation, and/or chemical scrubbing before release to the atmosphere. The major gaseous waste streams are released through stacks to provide atmospheric dilution for pollutants which are not removed during treatment.

Process water which may contain small quantities of radioactive or chemical pollutants is discharged, after treatment, to East Fork Poplar Creek, a small tributary of the Clinch River.

Burial grounds and holding ponds serve as repositories and treatment basins for the solid and liquid wastes generated by various activities of the Y-12 Plant. However, while great care is taken to remove and/or contain harmful pollutants, there are low levels of both radioactive and nonradioactive releases to the air and water media which are below established limits and/or guidelines. To date these releases have not caused any apparent significant impacts to the environment.

Air emissions include flue gases from the steam plant, process gases, low level radioactive particulates, fugitive dust (e.g., coal storage pile), and volatile organic materials from the burial grounds, treatment and storage basins, and sanitary landfills. Estimated amounts of gaseous emissions from Y-12 are presented in Table II-1.

Point and non-point liquid effluents from the Y-12 Plant area include those from New Hope Pond, Bethel Valley and Kerr Hollow Quarries, runoff from the coal storage pile, potential leachate from the sanitary landfill, as well as runoff, leachates, and seepage of liquids stored in the burial grounds. Provisions have been made or are being made for the containment and treatment or removal of some of the runoff and seepage.

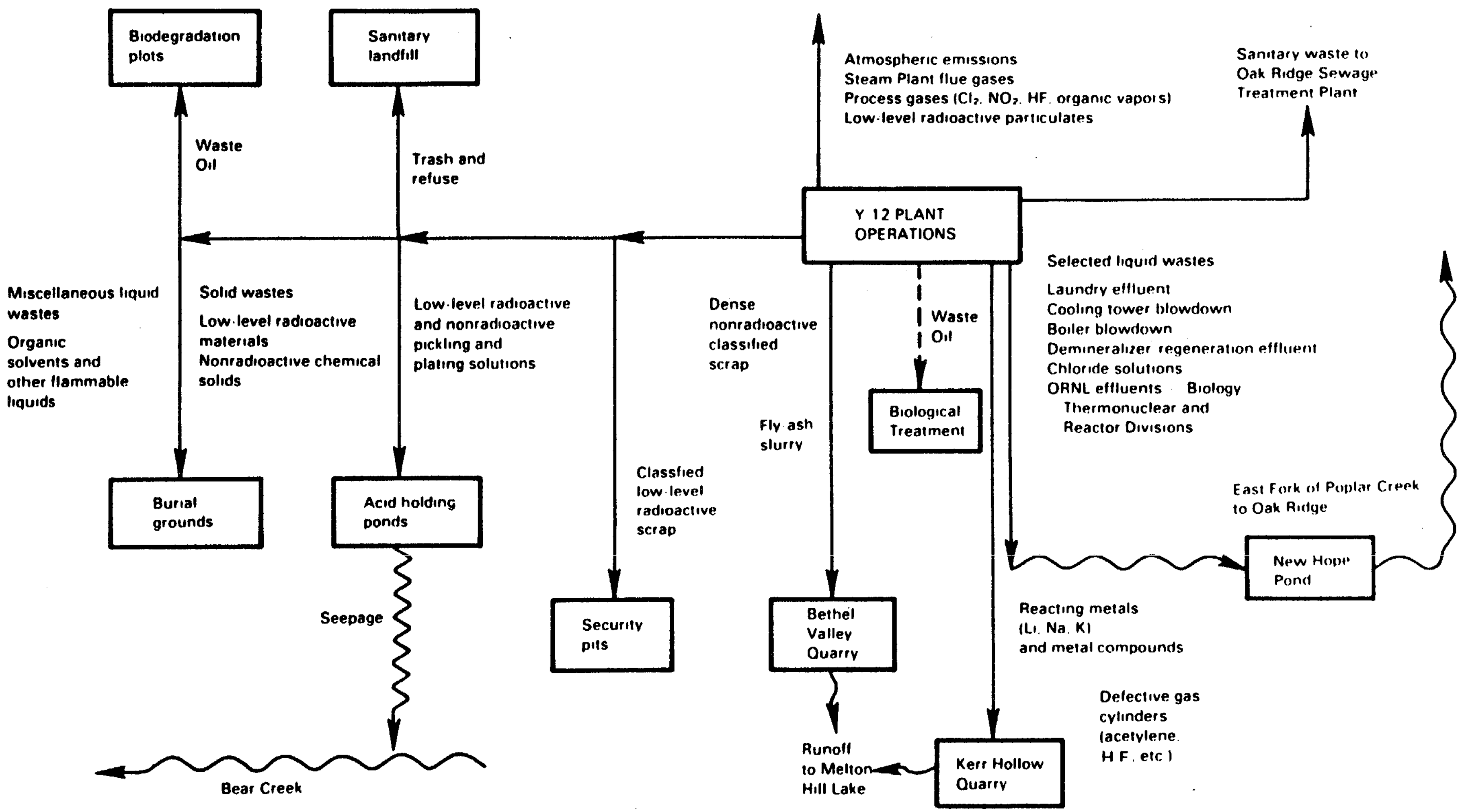

FIGURE II-2. SCHEMATIC OF EMISSIONS, EFFLUENTS, AND WASTES FROM THE Y-12 PLANT

TABLE II-1. ESTIMATES OF TOTAL NONRADIOACTIVE GASEOUS WASTES EMITTED ANNUALLY FROM THE Y-12 PLANT*

Waste	Source	Amount emitted annually (kg)	Amount emitted annually (lb)
Sulfur dioxide	Steam Plant, coal firing	2.8×10^6	6.2×10^6
Oxides of nitrogen	Steam Plant, coal and gas firing	0.95×10^6	2.1×10^6
	Uranium pickling; uranyl nitrate evaporation and denitration	1.8×10^4	4×10^4
Fluorides	Steam Plant, coal firing	6.4×10^3	14×10^3
Fly ash	Steam Plant, coal firing	0.24×10^6	0.53×10^6
Chlorine	Electrolytic cells	2.3×10^3	5×10^3
Hydrogen fluoride	Fluid-bed hydrofluorination of UO_2 to UF_4	2.1×10^4	4.6×10^4
Organic solvents	Fabrication processes	0.21×10^6	0.46×10^6

* Source: Alexander, 1979.

Information on air, water, effluent, and environmental quality for DOE's Oak Ridge complex is contained in the 1978 Annual Environmental Monitoring Report (Union Carbide, 1979b). Because of the importance of this information, an excerpt from the report summary is reproduced herein:

> "Surveillance of radioactivity in the Oak Ridge environs indicates that atmospheric concentrations of radioactivity were not significantly different from other areas in East Tennessee. Concentrations of radioactivity in the Clinch River and in fish collected from the river were less than 3 percent of the permissible concentration and intake guides for individuals in the offsite environment. While some radioactivity was released to the environment from plant operations, the concentrations in all of the media sampled were well below established standards...
>
> "The average total body dose to an Oak Ridge resident was estimated to be 0.05 millirem/yr as compared to approximately 100 mrem/yr from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.17 millirem. The cumulative total body dose to the population within an 80-kilometer radius of the Oak Ridge facilities resulting from 1978 effluents was calculated to be 5.6 man-rem. This dose may be compared to an estimated 74,000 man-rem to the same population resulting from natural background radiation.
>
> "The chemical water quality data in surface streams obtained from the water sampling program indicated that average concentrations resulting from plant effluents were in compliance with State stream guidelines with the exception of fluorides which were slightly over the limit."

The discharge of surface water includes general runoff from the Y-12 Plant area proper, from the burial grounds, and from the sanitary landfill. One of the current concerns is the runoff of water which originates as rain and percolates through the coal stored in a pile near the steam plant. The leachate from the coal pile is contaminated with both natural occurring inorganic and organic materials.

Another area of environmental concern is the emissions from the coal-fired steam generation plant. Its purpose is to provide steam for process use and for heating. The facility consists of four Wickes Boiler Company boilers of the two-drum bent-tube design. Each unit is capable of 113,000 kg/hr (250,000-lb/hr) steam generation at 17.6 kg/cm^2 (250 psig) and 260 C (500 F). Loads vary from less than 90,600 kg/hr (200,000 lb/hr) in summer to peaks of more than 272,000 kg/hr (600,000 lb/hr) in winter; average winter and summer loads are 204,000 kg/hr (450,000 lb/hr) and 90,600 kg/hr (200,000 lb/hr), respectively. Average annual coal usages are 77,000 metric tons (85,000 tons).

Electrostatic precipitators were installed in 1968 to remove particulates from the flue gases. The precipitators are one-chamber one-field units designed for 2860 m^3/min (101,000 abs cfm) at 143 C (290 F) with a tested collection efficiency of 98 percent or 0.16 Kg (0.35 lb) per million Btu of heat input for particulate emission. However, these units experienced overloading when the boilers were run at or near maximum (Table II-2). Consequently, the flue gas pollutants do not meet current emission standards (Table II-2). Sulfur dioxide emissions have recently been reduced by purchasing only low sulfur coal and blending it with the remaining high sulfur coal in proportions to yield emissions below the allowable standard. Unfortunately, the particulate emissions are still in noncompliance with emission standards.

Although Y-12 presently is experiencing particulate emission problems as well as other minor environmental problems, the benefits derived from the plant far exceed any losses imposed by these additional environmental burdens. In addition, steps are being taken to mitigate these problems (see Section II.A.5.). Oak Ridge is an integral part part of the nation's defense program. It produces components for both nuclear and thermonuclear weapons as well as lends fabrication support to weapons design laboratories. Research and development activities are conducted that cover both nuclear and alternative energy sources and involve almost every facet of modern technology. One of the most significant areas of contributions being made to national needs is that of energy research and development. These ongoing tasks are of prime importance for the national goal of achieving inexpensive and reliable sources of energy while decreasing U.S. reliance on foreign energy supplies.

A principal ORNL research effort at Y-12 is the estimation of risk to man from radiation. Such estimation is made by utilizing limited human exposure data and extrapolating experimental animal data to man. By interspecies comparison of radiation exposure in animals in Oak Ridge research projects, better predictions hopefully can be made.

II.A.2 Discontinue Operations

Part of DOE's current Congressionally-mandated mission is to support the national policy of maintaining an improved nuclear weapons stockpile. The Y-12 Plant is important to the fulfillment of that policy. Closing the Y-12 Plant would be detrimental to DOE's overall mission, would have a negative impact on the economy of the area, and would have only limited net impact on the environment. Specifically, utilities and resource consumption would be discontinued and emission of air pollutants and discharge of wastewaters would be significantly reduced but not eliminated. There would be a negative impact caused by the loss of jobs and salaries.

Operational accident threats which have a potential environmental impact would be eliminated by a shutdown, but other operations at the Federal complex would continue to have their impact on the local environment. Should the entire complex be vacated, it still is unlikely that the land could be returned to its original environmental state. The location and the industrial zoning of the land make it a likely candidate for continued industrial use.

TABLE II-2. PARTICULATE EMISSION DATA FOR Y-12 STEAM GENERATION PLANT[a]

Parameter Tested	Boiler Units #1	#2	#3	#4
Total Suspended Particulates				
Emission Rate (lb/hr)[b]	1008	600	2077	1615
Emission Rate (lbs/million Btu heat input)[b/c]	3.91	2.47	4.86	4.00

a Source: Stearns-Roger Incorporated, 1978a.

b Average value calculated from three individual tests.

c Tennessee allowable emission rate = 0.17 lbs/million Btu heat input.

II.A.3 Relocate Plant Operations

Environmental protection is a mandate in the conduct of all DOE programs, and moving the plant from its present location or transferring operations to another DOE facility would not result in a significant overall environmental improvement. Although a new plant or a relocation of operations to a different plant might result in improved environmental controls, the construction and operation of any new facilities at another site would have potentially similar effects on the environment, plus compound the situation because of construction-related impacts.

The existing environmental effects are such that only slight gains would be expected in moving production from Oak Ridge to some other DOE contractor. The significant potential adverse effects at the plant are related to accident situations for which extensive mitigating measures to protect the environment have been instituted. Any reduced environmental effects realized in Oak Ridge by moving any or all operations would likely be offset by the same effects being created at the other location. Furthermore, the economy of the Oak Ridge area would be severely depressed by this action.

II.A.4 Reduce Plant Operations and Change Objectives

Plant operations could be reduced by moving some manufacturing activities into the private sector--an alternative always under study as part of existing plant policy. As each new product enters the production cycle, make-buy analyses are conducted to determine if the product should be made at the plant or subcontracted to a private industry. When production within DOE offers cost or other advantages, private suppliers normally are not considered. This is most commonly the case when the new product requires a capital investment either by DOE or private industry.

A reduced plant workload could possibly decrease the plant's environmental impact. However, the plant's level of work is dependent on weapon systems schedules and requirements which are established by national policy.

Changing plant objectives could be accomplished by reducing the operations devoted to non-nuclear weapon component production and seeking new production assignments in the fields of energy research and development or in peaceful uses of atomic energy. It is believed that similar operations within the plant, independent of mission, would not change the environmental impact. However, a reduction in manufacturing operations associated with a different plant responsibility could reduce environmental interfaces. A change in plant mission is not expected and existing environmental controls are substandard in light of current mission responsibilities.

II.A.5 Continued Operation With Improved Environmental Controls

Despite the current compliance with permits, regulations, and standards for effluent and surface stream water quality, except the problem of air emission noncompliance, for particulates, there is a recognized need for more rigorous control in at least five areas:

- surface water discharge
- wastewater treatment
- air pollution control
- PCB disposal
- coal storage

II.A.5.a Surface Water Discharge. A source of potentially hazardous materials which may find their way into the surface water discharge are the burial grounds. Some of the liquids and leachable solids which have been buried there are known to seep from these sites.

Efforts already are underway to collect and to remove PCB's which are leaking from burial sites. Approximately 68,000 liters (18,000 gallons) of PCB-containing liquid which had been collected in the impoundment basins since 1969 recently has been removed and currently is stored in a steel tank. Other pollutants of concern are additional organic wastes as well as concentrated inorganic materials (e.g., metal finishing solutions) which have been discharged into the burial sites. Wastes currently stored in the burial grounds are being monitored carefully. In addition, the practice of discharging hazardous liquids into burial sites has been discontinued.

In most cases, the coal pile runoff (cf., II.A.5.e) is diluted naturally with other water to the extent that the concentrations of pollutants are decreased to reasonably acceptable levels. However, many of the constituents of the runoff from coal piles are included in the "priority pollutant" category and should be eliminated before the water reaches the receiving streams.

The collection and treatment of the runoff from the Y-12 coal storage pile will be a significant contribution to the elimination of potentially hazardous pollutants from the surface water discharge to the receiving streams. Technologically and economically, the most effective point of treatment is where the constituents are most highly concentrated—not after they are diluted. Currently, it is planned to design and construct this treatment facility as soon as funds are available.

II.A.5.b Wastewater Treatment. To eliminate the need for discharging certain concentrated liquid wastes into acid waste ponds, systems should be designed and constructed for their treatment. There are effective techniques available for treating metal finishing wastewaters so that the treated effluents can be discharged directly to surface waters. Generally, this treatment includes the reduction of hexavalent chromium to the trivalent state followed by the neutralization of the acidic wastes to precipitate the troublesome metals as hydroxides. The cyanides are destroyed via an alkaline chlorination route and the associated metals are precipitated.

Similarly, organic wastes could be subjected to biological treatment or incineration. Wastewaters with low concentrations of organic materials could be treated with activated carbon.

Another effective means of control is the minimization of discharge of hazardous materials with the wastewater by good housekeeping practices and by more vigorous control of the processes involved.

Presently, a central pollution control facility (CPCF) is being designed to treat liquid wastes from the Oak Ridge Y-12 Plant and construction funds will be requested.

Several sources of liquid pollutants have been identified for treatment on the basis of meeting the interim best available treatment economically achievable (BATEA) objectives of the Clean Water Act of 1977. The general categories of waste to be processes are:

- caustic and acidic wastes (heavy metals, acids, bases, nitrates, fluorides, cyanides, etc.);
- plating shop floor wastes (dilute caustic and acidic wastes); and
- contaminated waste water (low concentration of suspended uranium and beryllium metal particles).

These categories of waste represent a wide range of chemical compositions and concentrations. Generally, all the pollutants are inorganic chemicals. Organic pollutants are not expected to exceed trace concentration levels.

The principal treatment to be applied to the above mentioned aqueous waste categories is neutralization and solids removal. However, some of the chemical waste will undergo pretreatment before neutralization. For example, chromates will require pretreatment with ferrous sulfate to reduce Cr^{+6} to Cr^{+3} before neutralization. Also, cyanides must be destroyed.

The neutralization will precipitate heavy metals so that they can be removed by settling, filtration, etc. Neutralization also will eliminate excess hydrogen or hydroxyl ion concentrations (pH adjustment to 6.5 - 8.5). For heavy metals, the pH of waste should be adjusted between 7.5 and 10.5 in order to obtain precipitation under conditions of maximum insolubility.

Sludges from neutralized waste filtrate will be packaged and sealed in 55-gallon plastic drums for disposal in an appropriate landfill. Neutralized nitrate filtrate will be transferred to the existing denitrification facility for destruction. All other neutralized waste filtrates, including soluble salts of calcium and sodium, will be discharged to the East Fork of Poplar Creek. The dissolved solids of the stream are not expected to increase by more than 25 ppm (UCC-ND Engineering, 1978) and should not cause significant additional degradation of the quality of the stream.

Engineering and design activities have begun for this facility. It is anticipated that construction will begin in FY 1982 and that the facility will be in operation in FY 1984.

The wastewater which contains suspended uranium and beryllium metal particles will have to be treated by Ultrafiltration or other means before being released to the environment. The installation of this equipment should be completed in FY 1983.

II.A.5.c Air Pollution Control. It will be necessary to correct current particulate emissions to bring the steam plant within compliance standards. Reduced sulfur dioxide emissions have been achieved by switching to low sulfur coal as the fuel source.

Devices to control particulate matter are grouped into six classes: (1) inertial separators, (2) wet collectors, (3) baghouses, (4) single-stage electrical precipitators, (5) two-stage electrical precipitators, and (6) other particulate collecting equipment (Danielson, 1973). A recent study by Stearns-Roger, Inc. (1978b) has recommended the use of baghouses as the most efficient, cost-effective means of achieving compliance for particulate emissions.

Two million dollars were appropriated in FY 1981 for the design of emission control facilities for the reduction of particulate emissions at the Y-12 steam generating plant. Additional authorization and appropriations requested in FY 1982 will permit construction of the needed facilities on a schedule of completion by 1985.

II.A.5.d PCB Disposal. Polychlorinated biphenyls (PCB's) were used for many years in the Y-12 Plant as a machining coolant. This use was discontinued about 1972 when the human health hazards of PCB's were identified. PCB's also have been and currently are used as coolants or dielectrics in closed systems such as high-voltage capacitors and transformers. PCB's are extremely stable organic compounds--a factor which makes them useful as heat transfer agents. However, their stability also causes them to persist in the environment, thus increasing their environmental impact.

The management of the Y-12 Plant has taken steps required to protect the environment from PCB's which are stored in drums and/or electrical equipment, i.e., a properly diked building has been provided. In addition, the appropriate staff members have been advised of proper handling and transportation procedures for PCB's and PCB-contaminated materials. An inventory of electrical equipment also has been prepared and the annual removal of PCB's from this equipment for testing has been determined.

Samples are removed from 92 sealed transformers each year for analytical purposes. Approximately a pint is removed from each transformer, an aliquot taken for analysis, and the remainder deposited in a steel drum and held in the facility described above.

At the present time, obsolete and unserviceable electrical equipment containing PCB's is returned to the manufacturer for disposal and solid wastes contaminated with PCB's are removed by a contractor and disposed of in a controlled landfill (a procedure no longer acceptable after January 1, 1980). Liquid wastes containing PCB's must be stored pending the availability of a U.S. EPA-approved incinerator. A disposal option for PCB contaminated liquids includes solidification and disposal at an EPA-approved disposal landfill.

Currently, the major concern is the seepage of PCB-contaminated liquids from the burial sites where they were discharged several years ago. At the present time these liquids are being collected in the impoundment basin. Recently the liquids collected since 1969 have been removed from the impoundment basin and are stored in a steel tank. In the meantime, the drainage system in the area is being monitored carefully to detect any increases in the level of PCB's in streams, settlements, and sludges. Although there are some losses of PCB's from the impoundment basin, their levels at Y-12's Highway 95 monitoring station have neither violated existing standards nor caused any apparent deleterious impact on the environment.

Improved environmental controls associated with PCB's and their disposal can only include the continuation of monitoring activities, and the appropriate handling and storage of liquid wastes until an approved incinerator is available.

II.A.5.e Coal Pile. Waste water from two coal stockpiles is generated by leachate and drainage. The leachate from the coal pile is contaminated with both inorganic and organic materials which are naturally occurring. A variety of environmental factors affect the quality and quantity of emitted pollutants.

A recent study indicates that the neutralization of coal pile runoff can be accomplished by the addition of either NaOH or $Ca(OH)_2$. The rise of the pH from a value of approximately 2 to a value of greater than 7 completely removes the dissolved iron in the leachate in the form of iron hydroxide leaving a clear supernate which meets NPDES standards for pH and TSS. Neutralization also will remove manganese and some other soluble metals through the formation of their insoluble hydroxides. The use of lime as a neutralizing agent requires a longer mixing time than sodium hydroxide. Lime imparts a permanent hardness to treated water (Boyer, 1972).

II.B PREFERRED ACTION

The preferred action is to continue operation of Y-12 with improved environmental controls thereby meeting its assigned national responsibilities. The control of emissions from the Y-12 Steam Plant is the most urgently needed. Two million dollars were appropriated in FY 81 for the design of control facilities for the reduction of particulate emissions and additional authorization and appropriations have been requested in FY 1982 to permit construction of the facilities. If this funding becomes available, construction will be completed by 1985.

Another high priority item is the treatment of the coal pile runoff. Funding has been requested to construct a facility to treat this effluent stream.

Despite current compliance with existing NPDES permits, the water quality of the receiving streams will be enhanced with the completion of a project (81-D-120) to improve the quality of water released from the Y-12 facility by implementing a number of controls.

II.C LITERATURE CITED

Alexander, J. D. 1979. Background environmental information--Y-12 Plant. Report No. ORO-771. U.S. Department of Energy, Oak Ridge, TN.

Boyer, J. F. 1972. Status of coal mine drainage technology. Coal mining and processing. 9(1):56-59.

Danielson, J. A. (ed.). 1973. Air pollution engineering manual. 2nd ed. U.S. Environmental Protection Agency. Research Triangle Park, NC.

Stearns-Roger Incorporated. 1978a. Test report-particulate and sulfur dioxide testing, Union Carbide Corporation Y-12 Plant, Oak Ridge, Tennessee Units #1, 2, 3, and 4. Nuclear Division, Union Carbide, Oak Ridge, TN.

Stearns-Roger Incorporated. 1978b. Report on abatement particulate emissions from Y-12 steam plant. Nuclear Division, Union Carbide, Oak Ridge, TN.

UCC-ND Engineering. 1978. Conceptual design report for the control of effluents and pollutants Oak Ridge Y-12 Plant. Report No. Y/EN-238. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

Union Carbide. 1979a. Energy conservation survey. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

Union Carbide. 1979b. Environmental monitoring report, United States Department of Energy, Oak Ridge facilities, Report Y/UB-10. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

Watcher, R. A. and T. R. Blackwood. 1978. Source assessment: water pollution from coal storage areas, state of the art. Report No. EPA 600/2-78-004M. U.S. Environmental Protection Agency, Research Triangle Park, NC.

III
AFFECTED ENVIRONMENT

III.A GENERAL AREA DESCRIPTION

The Y-12 Plant is located about 4.8 km (3 mi) from the population center of Oak Ridge, Tennessee. Oak Ridge lies in an area between two mountain ranges and is bordered on one side by the Clinch River. The Cumberlands rise to 914 m (3,000 ft) or more about 16 km (10 mi) northwest, while 113 km (70 mi) to the southeast the Great Smokies reach an altitude of some 2,012 m (6,600 ft). Ninety square miles of this rolling wooded land was purchased by the U.S. Government in 1942 for the purpose of building the City of Oak Ridge and the site for several major plants (Y-12 included). They became part of the national program to develop an atomic bomb.

Oak Ridge and the associated Federal Reservation lands are within the region known as the Great Valley of the Tennessee River. It is part of the Valley and Ridge physiographic province and is characterized by alternating elongated and parallel valley troughs and ridges. The former are typically broader than the ridges.

Y-12 is situated in Bear Creek Valley at the eastern boundary of the Oak Ridge Federal Reservation. Y-12 is bounded by ridges on the north and south. The plant proper lies on the valley floor and northern slope of Chestnut Ridge. The occupied area is approximately 344 ha (850 acres) orientated in a northeast-southwest direction about 4 km (2.5 mi) long and 1 km (0.62 mi) wide.

III.B LAND USE

III.B.1 Regional Overview

The East Tennessee Development District (Figure III-1) is rural in character (Figure III-2). Knoxville is the district's regional center and the only city with a population in excess of 50,000. The cities of Alcoa, Harriman, Maryville, Morristown, Newport, and Oak Ridge make up communities within the 7,500 to 50,000 population range. All are incorporated and have a definite central core and provide major employment and trade opportunities. Table III-1 presents land-use data for the district. Of the district's 1,700,010 ha (4,200,800 acres), approximately 80 percent is in agricultural and forest land use. A breakdown of land use for Anderson and Roane counties is presented in Table III-2. These data are consistent with the region's land use.

III.B.2 Present Conditions

The city limits of Oak Ridge include approximately 22,637 ha (55,936 acres) with about 65 percent under federal control. Oak Ridge is an urban center with minimal agricultural activities in contrast to county land-use patterns. Non-federally owned lands consist of 5,510 ha (13,615 acres) and are divided into more than 9,500 parcels. Table III-3 categorizes these urban lands. The majority of these lands is either residential or vacant.

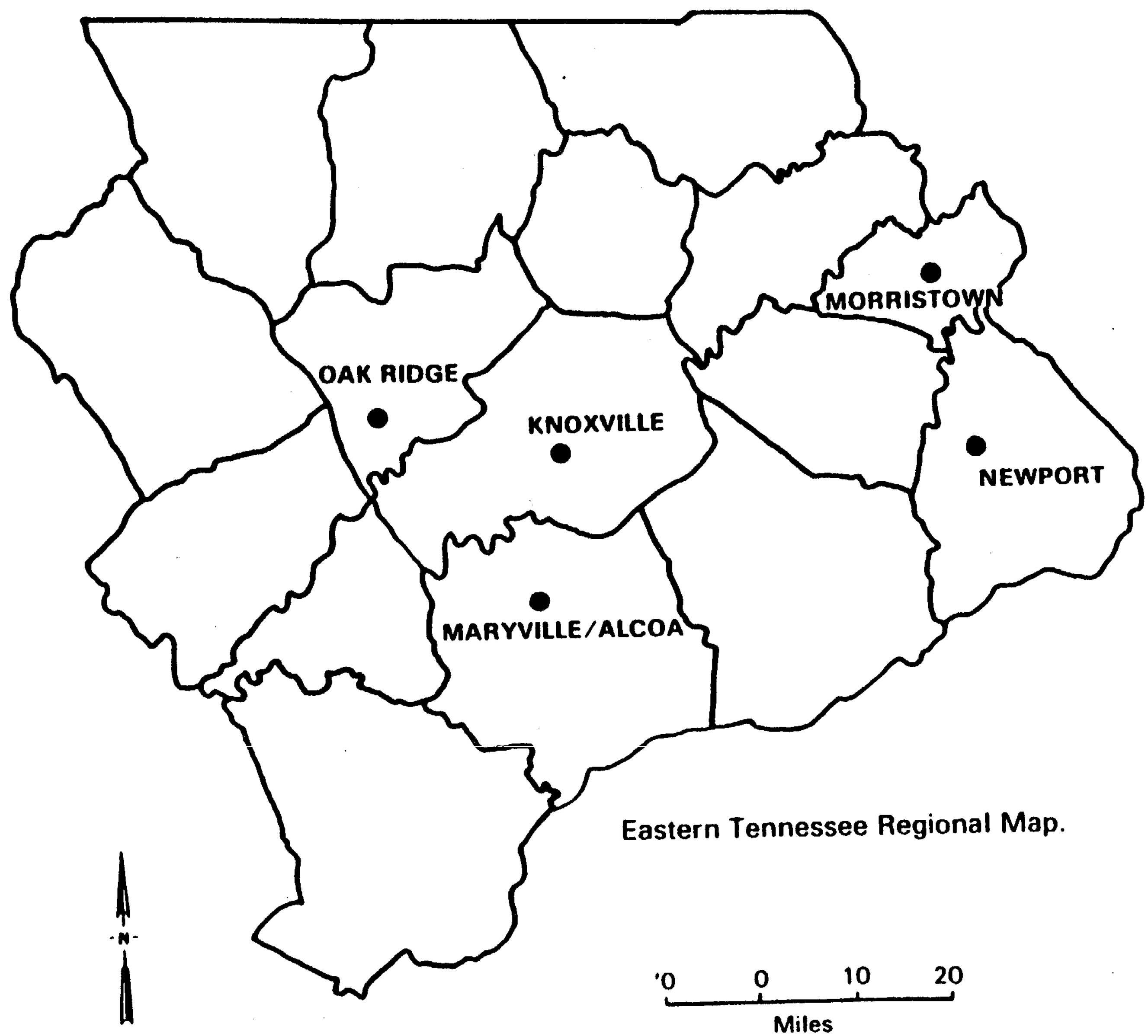

FIGURE III-1. EASTERN TENNESSEE REGIONAL MAP

Source: East Tennessee Development District, 1979.

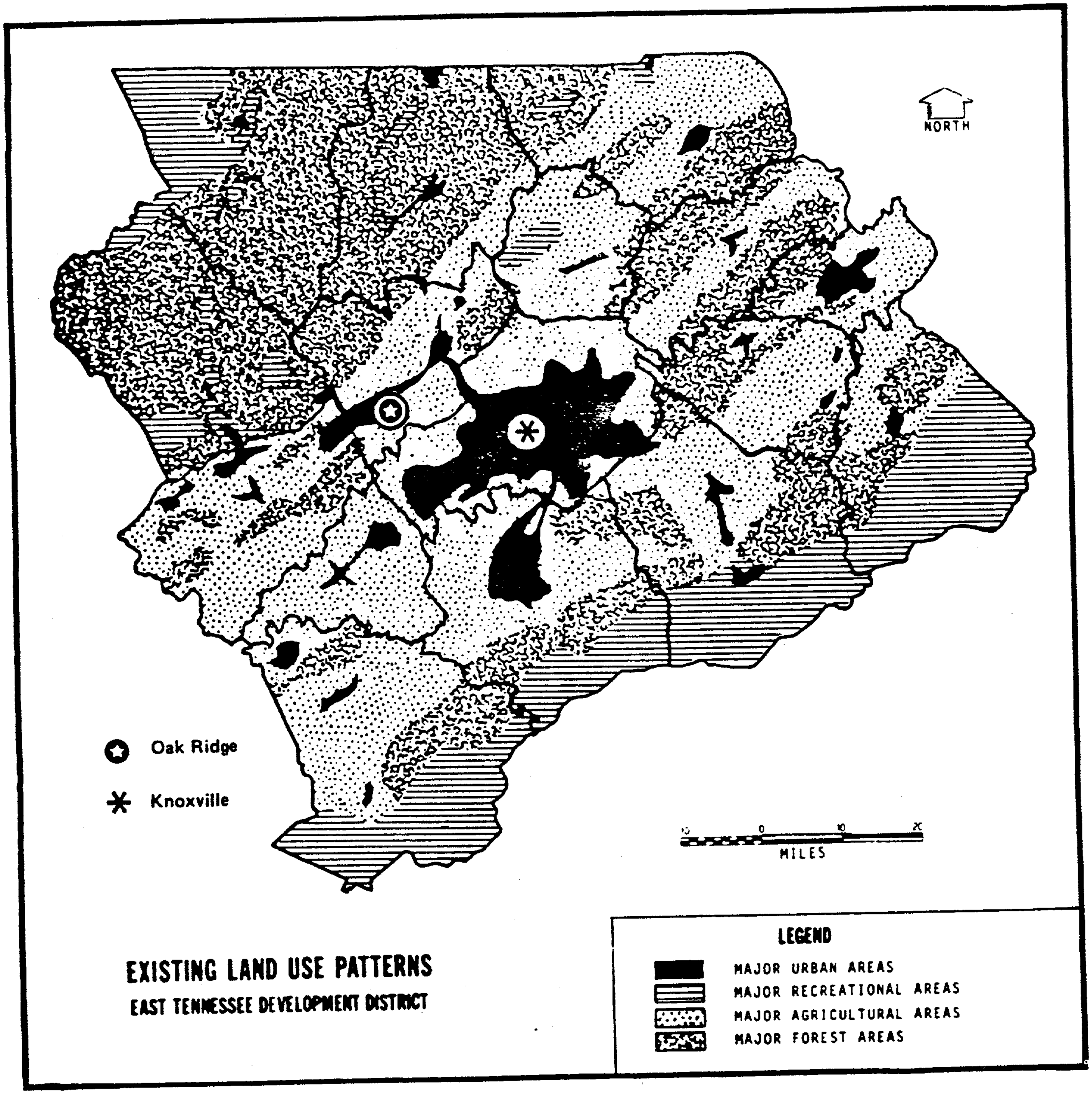

FIGURE III-2. EXISTING LAND USE PATTERNS

East Tennessee Development District

Source: East Tennessee Development District, 1979

TABLE III-1. LAND USE DATA FOR THE EASTERN TENNESSEE DEVELOPMENT DISTRICT[(a)]

Land-Use Category	Hectares	Acres	Percent
Residential	35,074	86,670	2.1
Commercial	1,950	4,820	0.1
Industrial	20,700	51,150	1.2
Recreational	269,129	665,030	15.8
Agricultural	685,904	1,694,900	40.4
Public and Quasi-Public	28,430	70,250	1.66
Forest	658,823	1,627,980	38.8
	1,700,010	4,200,800	100.06

(a) Source: East Tennessee Development District, 1979.

TABLE III-2. LAND USE DATA FOR ANDERSON AND ROANE COUNTIES, TENNESSEE[(a)]

Land-Use Category	Anderson County			Roane County		
	Hectares	Acres	Percentage	Hectares	Acres	Percentage
Residential	3,255	8,040	3.8	2,097	5,180	2.3
Commercial	146	360	0.20	93	230	0.11
Industrial[(b)]	134	330	0.20	413	1,020	0.46
Recreational	4,170	10,300	4.8	28,749	71,010	20.6
Agricultural	22,834	56,400	26.5	33,887	83,700	37.4
Public and Quasi-Public	3,053	7,540	3.5	1,968	4,860	2.2
Forested	46,567	115,020	54.0	35,126	86,760	38.8

(a) Source: East Tennessee Development District, 1979.

(b) Excludes 16,530 ha (40,830 acres) administered by DOE, 6,077 ha (15,010 acres) in Anderson, and 10,453 ha (25,820 acres) in Roane.

TABLE III-3. URBAN LAND USE DATA FOR THE CITY OF OAK RIDGE, TENNESSEE[a,b]

Land-Use Category	Hectares	Acres	Percentage
Residential	1,640	4,050	28.9
Vacant	2,247	5,550	39.6
Recreational	749	1,850	13.2
Commercial	104	256	1.8
Industrial	47	115	0.8
Public Transportation, Parking	480	1,185	8.5
Private Transportation	33	82	0.6
Utilities and Communications	52	129	0.9
Services	314	775	5.5

(a) Source: Oak Ridge Planning Department, 1978.

(b) Excludes federally-owned lands within the corporate city limits.

Over 1,903 ha (4,700 acres) of the vacant lands are suitable for housing (Oak Ridge Planning Department, 1978).

Approximately 14,970 ha (37,000 acres) of DOE-owned lands comprise the Oak Ridge Federal Reservation. Currently, the principal plant complexes on the reservation are as follows: Y-12, ORGDP, ORNL, and the CARL. Around each research and production facility is a buffer zone to provide security, space for expansion, and for isolation from the general public. About 5,666 ha (14,000 acres) are allocated for buffer zones around operating reactors, waste disposal areas, and streams that receive routine waste releases and burial ground seepages. Acreage used for high-voltage transmission lines, pipeline rights-of-way, transportation corridors, and security fences amounts to about 2,023 ha (5,000 acres).

About 80 percent of the Reservation is forested and a comprehensive forest management program is carried out. The Reservation is divided into 27 compartments, ranging in size from 148 to 486 ha (365 to 1,200 acres). Unique vegetational features are excluded from timber harvest operations. Some 40 individual sites are available for environmental research. Ecological studies made in the past include transport of foreign and natural materials from air and rainfall through vegetation, soil, and aquatic systems, radionuclide uptake and transport, cooling tower drift, low-intensity radiation of natural areas, animal collection, drainage from agricultural areas, and others.

Weapons manufacturing and primary research activities at Y-12 use some 1,377 ha (3,400 acres). This includes 1,012 ha (2,500 acres) of required buffer zone. Ecological and agricultural research is conducted on 810 ha (2,000 acres) of these buffer lands (Oak Ridge Operations, 1975). The Y-12 Plant site contains 261 buildings. Many buildings are arranged systematically in the valley portion of the site. They are served by an extensive system of streets, sidewalks, bus lines, railroads, office buildings, cafeterias, a dispensary, and fire and police departments. Land allocation, excluding wooded (47 ha or 115 acres) and grassy (85 ha or 210 acres) areas, for the plant is given below.

Use	Hectares	Acres
Production	36	90
ORNL Facilities	24	60
Storage	22	54
Development	4	9
Maintenance and General Shop	14	34
Construction Contractor	13	32

A few Y-12 Plant facilities lie beyond the plant perimeter (cf., Figure I-2). They have been installed over a period of some 20 years; their primary purpose is to protect the environment against the potentially adverse impact of this industrial complex. They include a large sanitary landfill, located about 3.2 km (2 mi) west of the plant, which is operated by Y-12 and serves all local DOE facilities. This landfill will be closed CY 1982, and a new facility will be installed 1.2 km (3/4 mi) south of the plant. Farther west are burial grounds for the disposal of toxic and radioactive wastes. Still farther west is the Bear Creek Monitoring Station at the point where Bear Creek turns north to leave the valley. About a mile south of the plant, in Bethel Valley, a large abandoned limestone quarry is being used to store fly ash generated by the Y-12 steam plant.

III.C SOCIOECONOMICS

III.C.1 Regional Overview

The region of analysis includes the City of Oak Ridge and Anderson and Roane counties situated in eastern Tennessee. The City of Oak Ridge is located in the eastern portion of the Tennessee Valley in eastern Roane and southwestern Anderson counties (Figure III-3). Oak Ridge is part of the Knoxville Standard Metropolitan Statistical Area (SMSA) which includes the counties of Anderson, Blount, Knox, and Union. Oak Ridge is also part of the East Tennessee Development District and is classified as a subregional center of the district.

Oak Ridge has been subject to fluctuations in population levels since the 1940's. From 1,000 rural families in 1940, the population reached a high of 75,000 in 1944. The city's population declined from this peak in the post-World War II period until a low of 27,169 was enumerated in the 1960 census. Besides federal policies that have caused fluctuations in the

FIGURE III-3. LOCATION OF OAK RIDGE IN EASTERN PORTION OF TENNESSEE VALLEY AND KNOXVILLE SMSA

Source: U.S. Department of Commerce, Bureau of Census, 1979 population, limited residential housing caused by scarce investment capital for development is found to be a hampering factor in the region's growth.

III.C.2 Population

As established by the Bureau of the Census, the 1970 populations for the City of Oak Ridge and the counties of Anderson and Roane were 28,319, 60,300, an 38,881, respectively (U.S. Department of Commerce, Bureau of the Census, 1979). Estimated 1978 populations for Oak Ridge, Anderson and Roane are 29,300, 62,700, and 41,600, respectively (East Tennessee Development District, 1979).

Table III-4 presents a breakdown of the two-county population by age and sex. As shown in this table, females comprise 52 percent of the total population. The median age for males was around 30.2 in both counties. The median age for females was 32.3 in Anderson and 32.6 in Roane County.

There were an estimated 22,400 and 14,800 households in Anderson and Roane counties, respectively. The average household size was 2.83 for Anderson and 2.91 for Roane County. Table III-5 presents a breakdown of households by age of head of the household.

Population growth figures for the City of Oak Ridge and the counties of Anderson and Roane have been projected by many government and private organizations, including the U.S. Bureau of the Census, the Tennessee Department of Economic and Community Development, and East Tennessee Development District. Depending upon the assumptions of net migration, natural population and general economic conditions that each agency makes, the population projections will differ accordingly. Actual and projected populations for the City of Oak Ridge and the counties of Anderson and Roane for different years are presented in Table III-6. From this table, it can be observed that the population of Oak Ridge should increase by approximately 12 percent by the year 1990 and remain constant up to the year 2000. On the other hand, the population of Anderson County is anticipated to increase by approximately 20 percent by the year 1990. Roane County will have a minimal 2 percent increase between 1978 and 1990 and a 1 percent increase between 1990 and the year 2000.

III.C.3 Labor Force and Employment

The 1979 labor force and employment information is presented in Table III-7. Since the City of Oak Ridge is bounded by Anderson and Roane counties, the labor force information applies to Oak Ridge also. However, the rate of unemployment of the two counties is not representative of Oak Ridge. The two counties have a total labor force of 46,360 people and of these 43,560 were reported employed during the spring and summer of 1979. The unemployment rate for Anderson County stood at 4.8 percent which was below the national average of 6.0 percent as of July 1979. On the other hand, Roane County had a higher level of unemployment at 8.4 percent.

TABLE III-4. A BREAKDOWN OF THE COUNTY POPULATION BY AGE AND SEX FOR COUNTIES OF ANDERSON AND ROANE, 1977[a]

Age Group	Anderson			Roane		
	Male	Female	Total	Male	Female	Total
0-5 Years	2,450	2,352	4,802	1,777	1,706	3,483
6-11	3,250	3,097	6,347	2,149	2,076	4,225
12-17	4,037	3,897	7,934	2,796	2,622	5,418
18-24	3,009	3,317	6,326	1,987	2,162	4,149
25-34	4,991	5,044	10,035	3,136	3,457	6,593
35-49	5,614	6,510	12,124	3,815	4,275	8,090
50-64	5,084	5,462	10,546	3,172	3,513	6,685
65 & Over	2,279	3,007	5,286	1,891	2,566	4,457
Median Age	30.2	32.3	-	30.3	32.6	-
TOTAL	30,714	32,686	63,400	20,723	22,377	43,100

(a) Source: Sales Management Inc., 1978.

TABLE III-5. HOUSEHOLDS BY AGE OF HEAD AND NUMBER OF PERSONS, 1977[a]

Age Group	Anderson	Roane
Under 25 Years	1,607	965
25-34	4,854	2,953
35-44	3,973	2,663
45-54	4,702	2,872
55-64	3,915	2,407
65 & Over	3,349	2,940
Total Household	22,400	14,800
Average Household Size	2.83	2.91

(a) Source: Sales Management Inc., 1978.

TABLE III-6. TOTAL POPULATION FOR OAK RIDGE, ANDERSON, AND ROANE COUNTIES--APRIL 1, 1950, 1960, AND 1970, AND PROVISIONAL ESTIMATES FOR 1978, 1980, 1990, AND 2000[a]

Year	Oak Ridge[1]	Anderson[2]	Roane[2]
1950	30,229	59,407	31,665
1960	27,169	60,032	39,133
1970	28,319	60,300	38,881
1978P	29,600	62,700	41,600
1980P	30,100	64,909	42,400
1990P	32,500	74,988	44,800
2000P	32,500	NA	45,400

(a) Source: (1) Oak Ridge Planning Department, 1978.
(2) East Tennessee Development District, 1979.

(P) Provisional estimates.

TABLE III-7. CIVILIAN LABOR FORCE EMPLOYMENT/ UNEMPLOYMENT STATUS FOR ANDERSON AND ROANE COUNTIES, SUMMER 1979[(a)]

Status	Anderson	Roane
Civilian Labor Force	30,440	15,920
Agricultural Employment	1,964	1,380
Non-Agricultural Employment	27,006[b]	13,210[b]
Total Employment	28,970	14,590
Unemployment	1,470	1,300
Percent Unemployed	4.8	8.4

(a) Source: Tennessee State Department of Economic and Community Development, Division of Industrial Development, 1979.

(b) Inclusive of Department of Energy employees.

III.C.4 Industrial Employment and Income

As shown in Table III-8, manufacturing plays an important role in the economy of Oak Ridge and the adjoining Anderson and Roane counties. In 1977, manufacturing employment stood at a total of 17,434 for the two counties, thereby employing 59 percent of the total industrial labor and supplying $244,053,000 or 72 percent of the industrial payroll.

The 1975 estimated per capita income was $6,111, $4,709, and $3,837 for the City of Oak Ridge and Anderson and Roane counties (U.S. Department of Commerce, Bureau of the Census, 1979). It was also reported that portion of Oak Ridge within Anderson County had a per capita income of $6,111 while the portion within Roane County had a per capita income of $6,620.

Table III-9 presents households grouped by effective buying income (EBI). From this table it can be observed that Anderson County residents have higher median average and per capita incomes than Roane County. This is attributed to two basic reasons. First, Anderson County is within the Knoxville Standard Metropolitan Statistical Area (SMSA). In general, counties within SMSA's have higher incomes as compared to counties outside SMSA's. Secondly, a larger portion of the City of Oak Ridge is in Anderson County. Income levels in Oak Ridge are reported to be higher than neighboring communities. This could contribute to the higher levels of income reported for Anderson County.

TABLE III-8. NUMBER OF ESTABLISHMENTS, EMPLOYMENT, AND PAYROLL BY INDUSTRY FOR ANDERSON AND ROANE COUNTIES, 1977[a]

Industry	Anderson			Roane		
	Number of Establishments	Number of Employees	Annual Payroll ($1,000)	Number of Establishments	Number of Employees	Annual Payroll ($1,000)
Agricultural	4	11	95	3	A	D
Mining	36	530	9,376	11	79	1,171
Contract Construction	86	421	3,354	66	296	2,577
Manufacturing	71	7,765	112,786	35	9,669	131,267
Transportation	45	402	4,803	29	288	2,987
Wholesale Trade	37	187	2,084	31	300	2,749
Retail Trade	388	3,415	22,399	230	1,635	9,652
Finance	8	291	2,474	47	335	2,921
Services[b]	317	2,736	22,777	178	1,074	6,174
Others	11	14	140	10	A	D
TOTAL	1,073	15,772	180,288	640	13,696	159,498

(a) Source: U.S. Department of Commerce, Bureau of the Census, 1979.

(b) Inclusive of Department of Energy employees.

A Less than 20 employees.

D Figures withheld to avoid disclosure of operations of individual establishments.

TABLE III-9. HOUSEHOLDS BY EFFECTIVE BUYING INCOME (EBI)* GROUP FOR ANDERSON AND ROANE COUNTIES, 1977[a]

Income Groups	Anderson	Roane
Under $3,000	2,318	1,023
$3,000 to $4,999	1,619	1,229
$5,000 to $7,999	2,197	1,616
$8,000 to $9,999	1,380	1,138
$10,000 to $14,999	4,046	2,753
$15,000 to $24,999	6,937	4,489
$25,000 to $49,999	3,619	1,820
$50,000 or More	284	132
Median Household EBI	$14,609	$13,267
Average Household EBI	$15,936	$14,614
Per Capita EBI	$ 5,630	$ 5,018

* The term "Effective Buying Income (EBI)" used in this text is equal to disposal personal income less compensations paid to military and diplomatic personnel stationed overseas.

(a) Sales Management Inc., 1978.

III.D GEOLOGY, SEISMOLOGY, SOILS, AND SEDIMENTS

III.D.1 Regional Overview

The Y-12 plant site, surrounded by the Oak Ridge Reservation, lies within the Valley and Ridge Physiographic Province. A physiographic province is an area of similar lithology, stratigraphy, structure, and geomorphic history. The Valley and Ridge Province is situated between the Blue Ridge Province to the east and the Appalachian Plateaus to the west. This province occupies roughly 7,407,400 ha (18,304,000 acres). (Hunt, 1974).

III.D.2 Geology

III.D.2.a Topography. The topography of the Oak Ridge reservation is typical of the Valley and Ridge Province, being characterized by sub-parallel northeast trending ridges and valleys. It reflects the geologic structure of the area which consists of generally southeast-dipping strata; the different lithologies of the formations result in different rates of weathering and erosion. The ridge-producing formations of the Oak Ridge area are the Rome Formation, the Knox Group, the Rockwood Formation, and the Fort Payne Chert. Most of the valleys are underlain by the Conasauga Group and the Chickamauga Limestone.

Altitudes within the area range from 226 m (741 ft) in the southwestern part of the area to 413 m (1,356 ft) at Melton Hill, which is also in the southwestern part of the area, the maximum relief being 187 m (615 ft). The region is thought to have undergone two cycles of erosion and to be presently in a third. The surface resulting from the last complete cycle is represented by the tops of the present ridges which have a more or less uniform altitude in the Oak Ridge area (McMaster, 1964).

III.D.2.b Geologic History. The Oak Ridge Reservation is underlain by nine geologic formations or groups ranging from Early Cambrian to Early Mississippian. The formations are of sedimentary origin, both chemical (limestone and dolomite) and clastic (sandstone and shale) and from oldest to youngest include the Rome Formation, the Conasauga Group, the Knox Group, the Chickamauga Limestone, the Sequatchie Formation, the Rockwood Formation, the Chattanooga Shale, the Maury Formation, and the Fort Payne Chert.

Figure III-4 illustrates an approximate stratigraphic column of the sediments exposed in the Oak Ridge area with a brief description of the lithologies present. Of these the most important from the standpoint of occurrence in the Oak Ridge area are the Rome Formation, the Conasauga Group, the Knox Group, and the Chickamauga Limestone. The others occupy relatively small parts of the basin. A geologic map of the Y-12 area is presented in Figure III-5. A geologic cross section for line AA' in Figure III-5 is illustrated in Figure III-6.

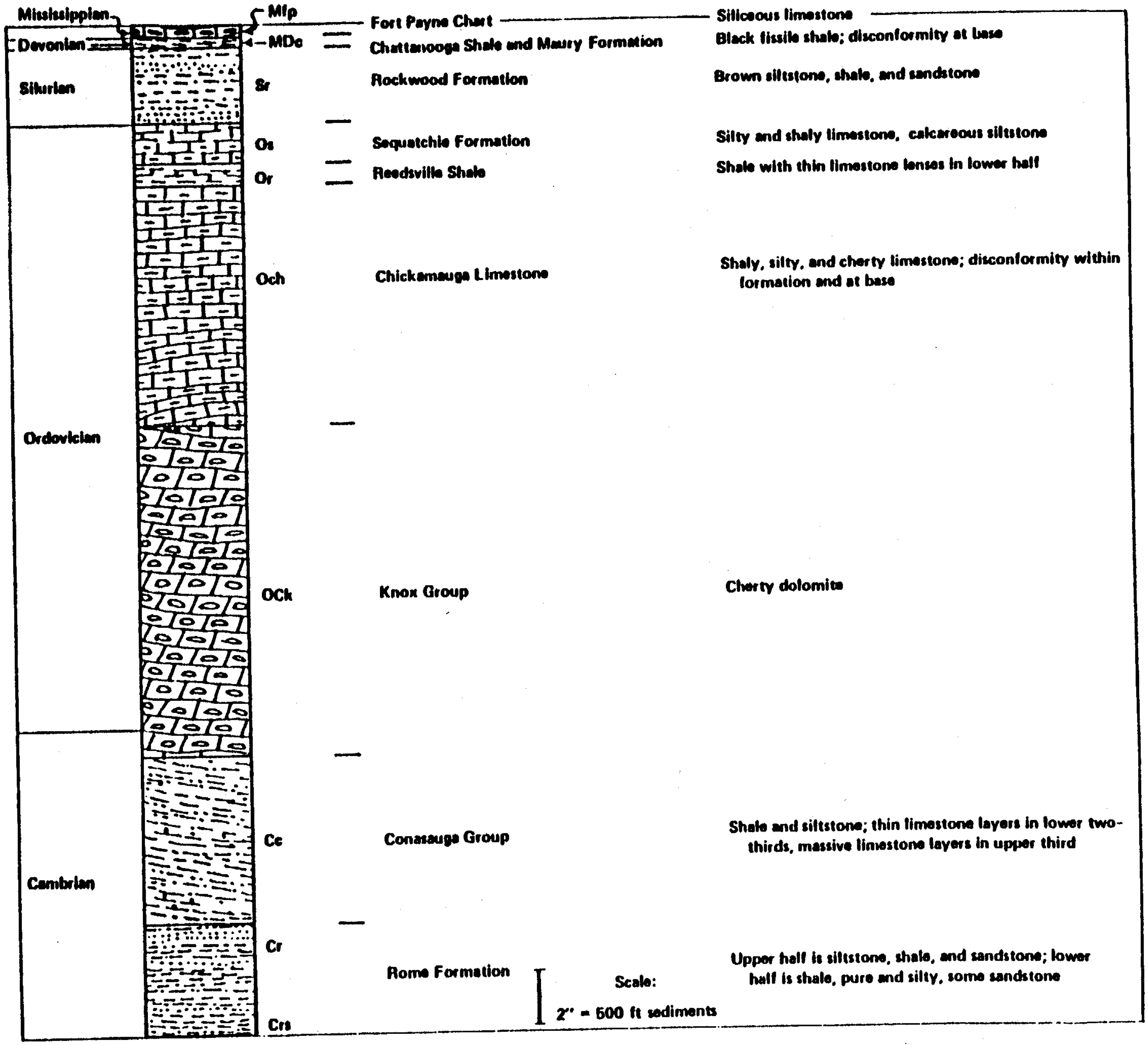

FIGURE III-4. APPROXIMATE STRATIGRAPHIC SECTION OF SEDIMENT EXPOSED IN OAK RIDGE, TENNESSEE AREA

Source: McMaster, 1964

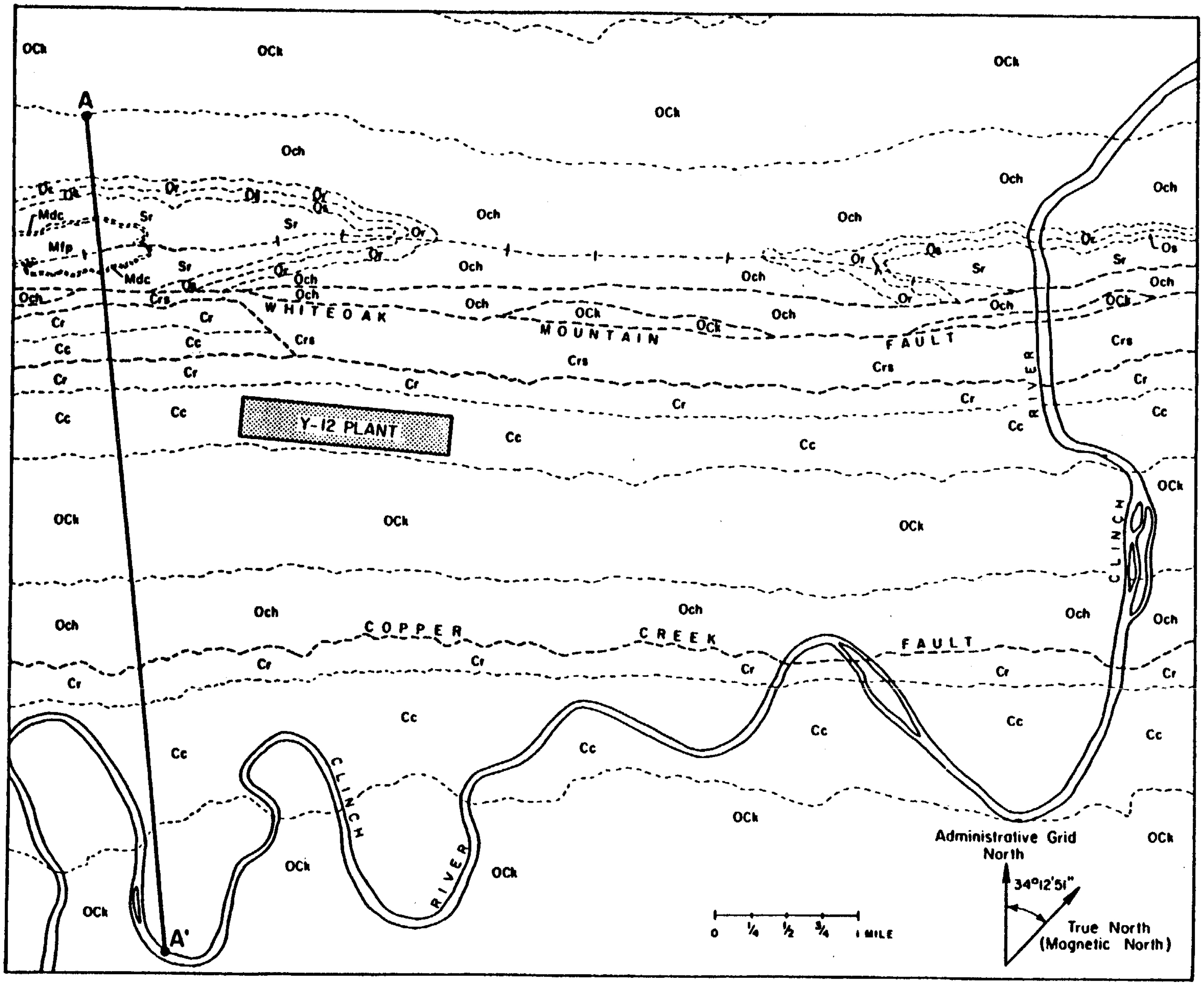

FIGURE III-5. GEOLOGIC MAP OF AREA AROUND Y-12 PLANT. (ABBREVIATED NAMES OF GEOLOGIC FORMATION ARE IDENTIFIED IN FIGURE III-4)

Source: McMaster, 1964

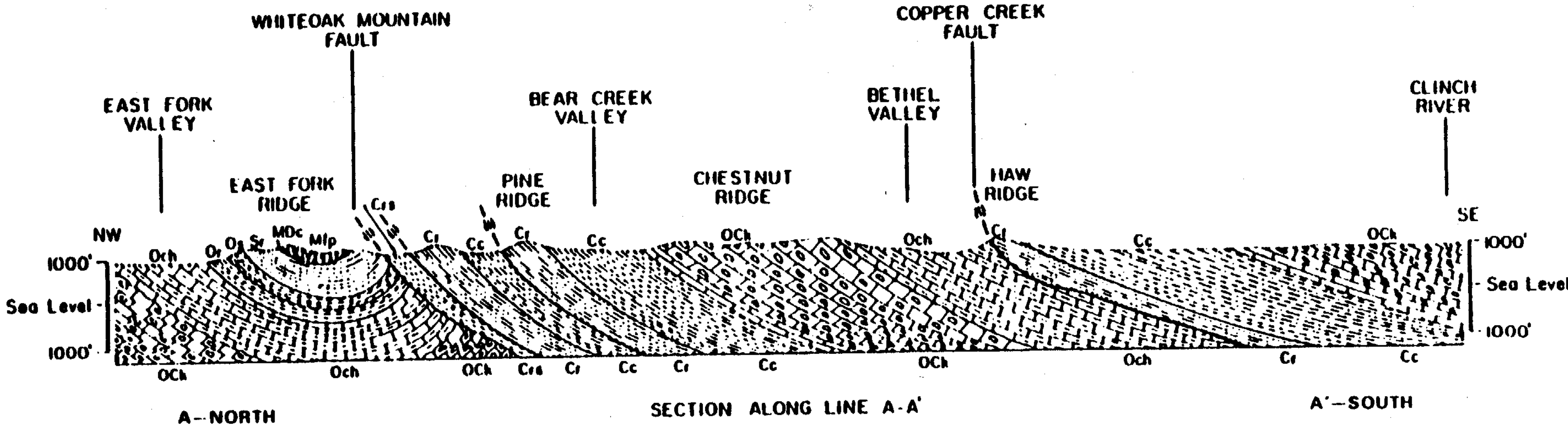

FIGURE III-6. GEOLOGIC CROSS SECTION FROM POINT A TO POINT A' IN FIGURE III-5.

Source: McMaster, 1964.

The different lithologies of the formations result in different rates of weathering and erosion. The more resistant ridge-producing formations are the Rome Formation, the Knox Group, the Rockwood Formation, and the Fort Payne Chert. Most of the valleys are underlain by the Conasauga Group and the Chickamauga Limestone (Oak Ridge Operations, 1975).

Three disconformities are present in the column: one separating Lower and Middle Ordovician rocks, one within the Middle Ordovician rocks, and one separating Lower Silurian and Devonian and Mississippian rocks. The total stratigraphic thickness of the sediments in the area is approximately 2,743 m (9,000 ft) (McMaster, 1964).

A brief lithological description of the sediment exposed in the Oak Ridge area is presented below. Further details can be obtained in McMaster (1964).

Cambrian and Ordovician Systems

Rome Formation. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and dolomite (locally). Siltstone and shale form the bulk of the formation in the Oak Ridge area. Sandstone beds in the Rome Formation, which range in thickness from 7.5-36 cm (3-14 in) are more abundant in the upper half of the formation than in the lower.

The sandstone is composed of light-gray to light-brown, fine- to medium-grained quartz sand cemented with silica or iron oxide. In places, the sand is so well cemented as to be quartzitic. Weathered surfaces of the sandstone generally are dark brown or red-brown.

Siltstone in the Rome Formation is generally light to dark brown and green-brown, thin-bedded, and has irregular bedding surfaces along which small flakes of mica are concentrated.

The total thickness of that part of the Rome Formation exposed in the Oak Ridge area is about 244-305 m (800-1,000 ft).

Conasauga Group. The Conasauga is primarily calcareous shale interlayered with limestone and siltstone. The shale of the Conasauga ranges from pure clay shale to silty shale and is brown, tan, buff, olive green, green and dull purple. Dark-gray, dense to crystalline, nodular, thin-bedded, silty limestone is interbedded with the shale and siltstone in the lower two-thirds of the group. Siltstone, which is brown, red-brown, buff, and tan, is present throughout the lower four-fifths of the group and is abundant in the layers underlying a line of knob-like hills on the northwestern sides of the valleys underlain by the Conasauga.

Alternating beds of shale and light-gray, dense to crystalline, regularly-bedded limestone are present about 152 m (500 ft) below the top of the group. These beds are overlain by about 91 m (300 ft) of massive, light- to medium-gray, dense to coarsely crystalline or oolitic limestone. The upper limestone beds of the Conasauga are used in many places in East Tennessee as a source of quarry stone for road aggregate; most of this limestone is fairly pure and the oolitic beds are composed of nearly pure calcium carbonate.

The thickness of the Conasauga Group is difficult to measure because it is highly folded and faulted but is estimated to be 457 m or more (1,500+ ft).

Knox Group. The Knox is composed primarily of massive, siliceous dolomite. The group can be divided into five formations on the basis of lithologic variation, but on the accompanying map the group is undivided.

The general variation in lithology is from massive, dark-gray, crystalline, very cherty dolomite at the base to generally less massively bedded, lighter-gray, dense to finely crystalline, less cherty dolomite at the top. Thin beds of light-gray, dense limestone are present in the upper part and thin beds of relatively pure sandstone occur about 305 m (1,000 ft) above the base of the group. Outcrops of the dolomite are not abundant due to the rapid weathering and deep soil cover; however, on the northwestern sides of ridges underlain by the group, erosion has removed the soil cover to an extent that outcrops are fairly common.

The age of the Knox is late Cambrian and early Ordovician. The total thickness is about 914 m (3,000 ft).

Chickamauga Limestone and Reedsville Shale. Lithologically, the Chickamauga is extremely variable, although the entire sequence is calcareous. In East Fork Valley, the lowermost beds of the Chickamauga are composed of discontinuous thin layers of bentonitic material, gray clay shale with obscure bedding, thin-bedded, maroon, calcareous siltstone up to 15 m (50 ft) thick, and gray, calcareous, micaceous siltstone. A sequence of limestone approximately 457 m (1,500 ft) thick lies above these layers. The limestone is dominantly light to medium gray and blue-gray, dense to finely crystalline, shaly, and thin-bedded and contains variable amounts of chert. Near the top of this limestone sequence are two bentonite beds which lie about 15 m (50 ft) apart, stratigraphically. Above the upper bentonite is a 12-m (40-ft) sequence of yellow and maroon, calcareous siltstone beds at the top of which is an apparently small disconformity. Blue-gray limestone, which is coarsely crystalline, extremely fossiliferous, relatively pure, and more massively bedded than the underlying limestones, lies above the disconformity. Unlike the layers of shaly limestone below, this lithology is relatively homogeneous along strike.

The coarsely crystalline limestone grades upward into the Reedsville Shale, a calcareous, tan to orange-brown, fissile, thin-bedded, fossiliferous shale, which is the uppermost unit of the Chickamauga Limestone. This unit is 61-76 m (200-250 ft) thick.

Sequatchie Formation. The Sequatchie is predominantly maroon calcareous siltstone and maroon, silty and shaly limestone mottled with green. The formation contains a minor quantity of gray shaly limestone. The beds are uniform and generally from 5-15 cm (2-6 in) thick, although there are more massive beds. There is a striking similarity between the maroon siltstone of this formation and those of the Chicagomauga in Bethel Valley.

Silurian System

Rockwood Formation. The lithology of the Rockwood is variable. Alternating thin (2.5-7.6 cm or 1-3 in) beds of siltstone and shale form the bulk of the formation. Beds of massive, medium-grained, iron-stained, well-cemented sandstone are present near the base. The upper half of the formation contains thin ferruginous layers which are of two general types: oolitic, shaly, and silty iron oxide containing many crinoid stem fossils up to 25 cm (10 in) thick and conglomeratic, pyritic, sandy layers up to 1 m (3 ft) thick.

The age of the Rockwood is early Silurian. Its thickness in the Oak Ridge area is approximately 210 m (690 ft).

Devonian and Mississippian Systems

Chattanooga Shale and Maury Formation. The Chattanooga Shale is composed of black, bituminous, fissile, pyritic shale which, in places, is sandy. Above the Chattanooga Shale lies a 60 cm-thick (2-ft) layer of blue-green phosphatic shale known as the Maury Formation. The Chattanooga Shale is generally considered to be both Devonian and Mississippian in age in this region. The Maury Formation is early Mississippian in age.

Fort Payne Chert. In the Oak Ridge area, the Fort Payne Chert is composed primarily of very dense chalcedonic chert which is blue-gray, massive, and contains few fossils. Thin, irregular beds of sand and silt, interbedded with white chert, may be present. The formation is early Mississippian in age and is about 46 m (150 ft) thick in this region.

III.D.2.c Mineral Resources. Minerals are found in the Oak Ridge area, but, in general, they are not present in commercially significant levels. Limestone is currently being mined in one quarry within the city limits and this is the only such current operation in Oak Ridge (Oak Ridge Planning Department, 1979). Dolomite, coal, oil, gas, zinc, and some barite and fluoride are mined in neighboring parts of the region (Figure III-7).

III.D.3 Seismology

The Oak Ridge reservation is crossed by two major thrust faults: (1) the Copper Creek fault in the southeastern part of the area and (2) the White-Oak Mountain fault in the northwestern part (Figure III-5). The strata and the fault zones dip primarily to the southeast. The Whiteoak Mountain fault in the Oak Ridge area exhibits several subsidiary features, including branch faults, a syncline northwest of the fault, and two slices of

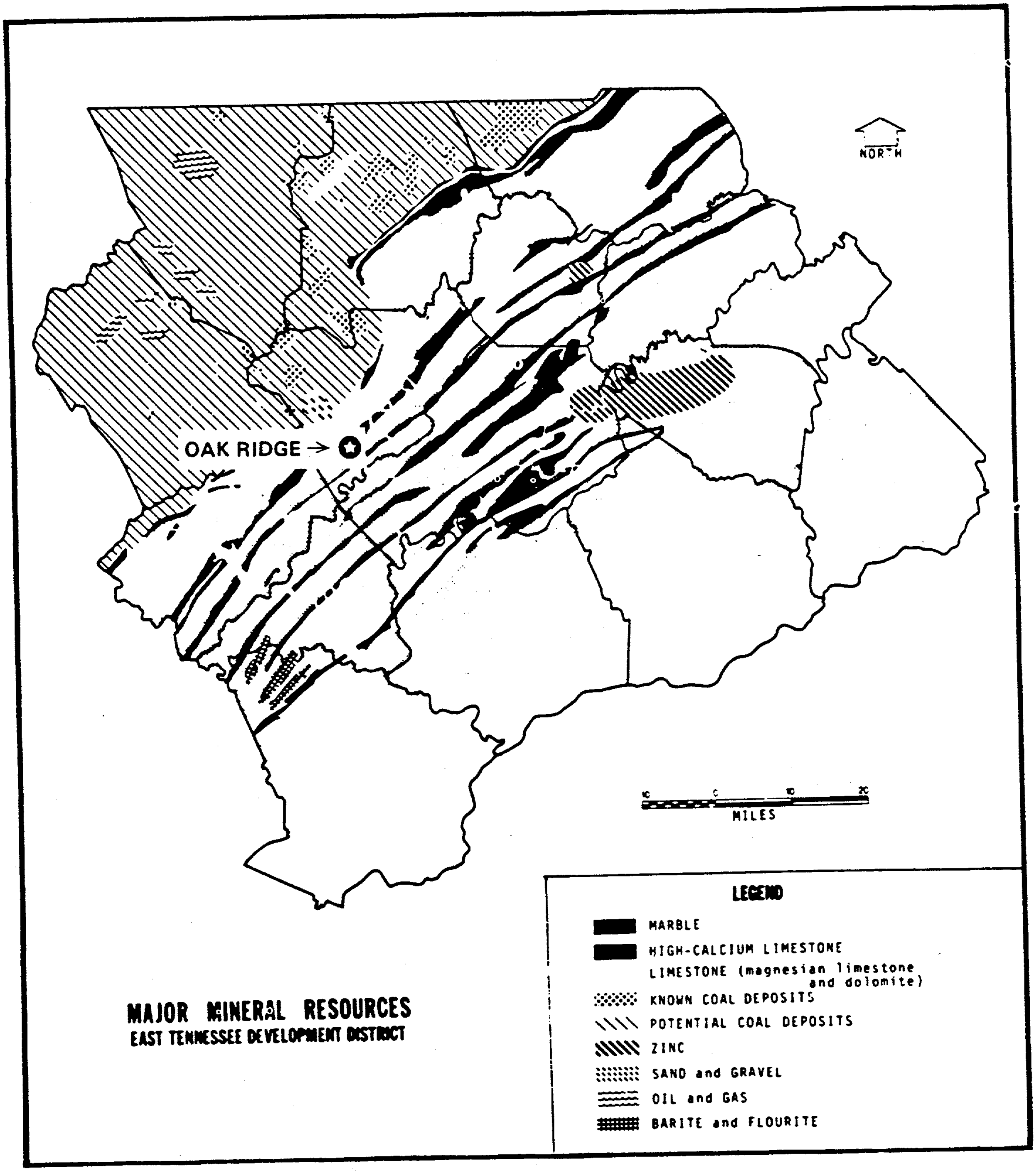

FIGURE III-7. MAJOR MINERAL RESOURCES

East Tennessee
Development District

Source: East Tennessee Development District Land Use Plan (1979) dolomite of the Knox Group (McMaster, 1964). A review of pertinent literature has indicated no reports of earthquake activity or surface rupturing associated with any of the faults within the site vicinity, and the possibility of these events is considered extremely unlikely (Oak Ridge Operations, 1975).

Forty recorded earthquakes have occurred within 250 km (155 miles) of the site. The most severe local earthquake occurred northeast of Knoxville on March 28, 1913, with an epicentral modified Mercalli intensity of VII. Moderately strong epicentral shaking (maximum intensity VI) also occurred from local events in 1956 and 1844. Comparable intensities were also observed in the Knoxville-Oak Ridge area during the 1811-1812 Mississippi Valley, Missouri, earthquakes and the 1886 Charleston, South Carolina, earthquake, although the epicenters of these large earthquakes were located over 450 km (280 mi) from Oak Ridge (Oak Ridge Operations, 1975).

The largest earthquakes recorded in the Southern Appalachians were those occurring near Gadsden, Alabama (January 27-28, 1905, maximum intensity VIII), and Giles County, Virginia (May 31, 1897, maximum intensity VIII). These earthquakes were located about 250 km (155 mi) and 350 km (220 mi) respectively, from Oak Ridge and, although they were most likely felt in the area, the intensities at that distance were far below the damaging level (Oak Ridge Operations, 1975).

There are many ways to classify the seismic risk of an area. Most maps of relative risk mark zones with an arbitrary numerical or alphabetical scale. For example, a now superseded seismic risk map for the United States had four zones ranging from no hazard (Zone 0) to most hazard (Zone 3). Using this classification, the Oak Ridge Reservation lies in Zone 2 which is an area of moderate activity.

Using a new probabilistic seismic risk map illustrated in Figure III-8, Oak Ridge lies close to the 0.10 contour (Bolt, 1978). That is, the chance is only 1 in 10 that an average peak ground acceleration of 0.1 gravity units or greater will occur within 50 years.

III.D.4 Soils

The soils of the Oak Ridge area belong to the broad group of Red-Yellow Podzolic and Reddish-Brown soils that occur extensively in the southeastern United States over most of the Coastal Plain, much of the Piedmont, and the southern ends of the Appalachian plateaus and Valley and Ridge Province. They are strongly leached soils, acid in reaction, and low in organic matter and mineral plant nutrients. These soils developed under forests. The surface soils are generally light colored and somewhat sandy; the subsoils contain more clay, are tougher, and red, yellow, or mottled in color (Carroll, 1961).

The soils are broadly divided into two topographic groups in the Valley and Ridge Province: residual soils on the ridges and broader valley

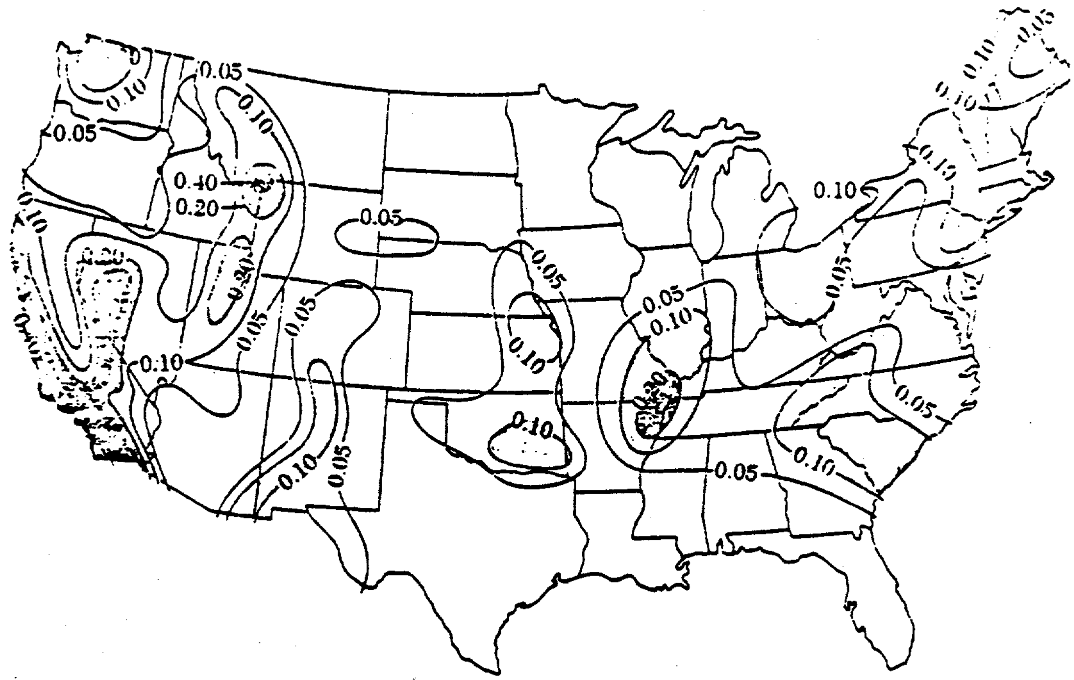

FIGURE III-8.
Seismic risk map for the United States. The contours indicate effective peak, or maximum, acceleration levels (values are in decimal fractions of gravity) that might be expected (with odds of only 1 in 10) to be exceeded during a 50-year period.

Source: Bolt, 1978

floors, and alluvial and terrace soils associated with stream channels (Carroll, 1961).

Residual soils are of two soil associations within the project area (U.S. Soil Conservation Service, 1974). The Wallen-Talbott-Montevalls soil association consists of shallow to moderately deep soils, excessively drained or well-drained derived from sandstone, shale, and limestone. The Fullerton-Dewey soil association consists of deep, well-drained soils derived from dolomitic limestone. The former association is found on the steep ridges and the valley floors. Soils of the hilly or rolling countryside are predominantly of the Fullerton-Dewey association (U.S. Soil Conservation Service, 1974).

Soils have developed under forests and contain an A-horizon that is typically light colored and covers a tougher, clayey subsoil of red, yellow, or mottled color. The major soils are generally silty rather than sandy or clayey. However, considerable clay may be present in the B-horizon. Soils derived from the Knox Formation contain kaolinite as their principal clay, whereas illite and vermiculite constitute the bulk of Conasauga clay. Most of the Chickamauga yields clay occurring as kaolinite and illite, although patches with significant amounts of montmorillonite have been noted. The soils of the Oak Ridge area are relatively infertile and ill-suited to agriculture. Approximately 15 percent of the land is favorably productive; 35 percent is characterized by medium productivity; and the remaining 50 percent is not suitable for agriculture (Kitchings and Mann, 1976).

The soil potential for agriculture productivity is based on a survey of physical and chemical characteristics of soil and on topographic and conservation features of the landscape. The most significant characteristics considered are depth, texture, structure, organic matter, fertility, reaction, drainage, moisture-holding capacity, erosion, stoniness, and slope. Soils are commonly ranked into five classes (first, second, third, fourth and fifth), first class soils being most productive and fifth class soils being least productive (Oak Ridge Operations, 1975).

First class (I) soils are very productive, easily worked, and possess simple problems with conservation.

Second class (II) soils are moderately productive, less workable, and have more problems than Class I.

Third class (III) soils are adverse to productivity and workability with greater conservation problems. Intense management practices are required and growth of field crops is impractical.

Fourth class (IV) soils are not suitable for growth of crops but may be moderately productive for pasture.

Fifth class (V) soils are not suitable for crops or pasture; forestry is the best use of the land.

Approximately 35 percent of the Oak Ridge Reservation is Class IV whereas 50 percent is Class V. The Y-12 site is situated on Class IV and Class V soils (Oak Ridge Operations, 1975).

Eighteen soil types have been determined as prime and unique farmland soil in Anderson County (Soil Conservation Service, 1979). Since slope is a key factor in determining a soil's compatibility with agricultural pursuit, prime/unique farmland soils are confined to the valley floors in the project area. None are located within the Y-12 Plant site nor are any present along the slopes of the surrounding ridges. However, numerous narrow strips (30.5-152 m or 100-500 ft wide) occur west of the Y-12 Plant along Bear Creek and its tributaries. All these soils are siltloams and are either Greendale, Hamplen, or Headvale soil types.

III.D.5 Sediments

Stream sediments are an environmental concern around the Y-12 installation because there have been accidental discharges of polychlorinated biphenyls (PCB) and mercury to surface waters in the past. Both chemicals are characterized as primarily residing in sediment deposits (vs. surface water), persistent in the environment (vs. readily decomposed), bioconcentrated by living organisms in the food chain, and toxic to the biota (Ljunggren et al., 1971; Dolar et al., 1971; Hammond et al., 1972).

Sediment samples reveal that both Bear Creek and East Fork Poplar Creek have higher mercury and PCB values than control streams located in the vicinity (Alexander, 1979). Mercury concentrations for East Fork Poplar Creek ranged from 0.9 to 11.3 ppm while samples from Bear Creek were <1 ppm (Alexander, 1979). The uncontaminated Grassy Creek contained <0.05 ppm total mercury. PCB values for East Fork Poplar Creek range from <0.1 to 0.6 ppm as compared to <0.1 reported for Grassy Creek (Alexander, 1979).

III.E WATER RESOURCES AND HYDROLOGY

III.E.1 Regional Overview

The Clinch River is the major hydrologic feature of the Y-12 plant site area. Headwaters of the Clinch River are in Tazwell County, Virginia. From the headwaters, the Clinch River flows approximately 350 river miles in a southwesterly direction to its confluence with the Tennessee River near Kingston, Tennessee. The northwestern boundary of the basin is formed by the Cumberland Mountains. The southeastern boundary follows Clinch Mountain and Black Oak Ridge (Exxon Nuclear Company, Inc., 1977).

The occurrence of groundwater in the Valley and Ridge Province in eastern Tennessee is usually restricted to fractures in the rock; some have been enlarged by weathering processes, particularly in the calcareous rocks. The quantity of water available and general flow characteristics usually depend on the size and number of fractures encountered. Unconsolidated deposits of gravel, sand, and silt are found principally along streams in East Tennessee but are not important aquifers because these deposits are usually thin. Small quantities of water are available in residual soils that overlie the rock (Exxon Nuclear Company, Inc., 1977).

III.E.2 Water Resources

III.E.2.a Surface Water

Rivers. The Oak Ridge area is drained by the Clinch River and some smaller creeks, all of which are tributaries of the Clinch River (Figure III-9). These tributaries include (a) White Oak Creek, (b) Poplar Creek, (c) East Fork Poplar Creek, and (d) Bear Creek. The Y-12 Plant discharges wastewater into both Bear Creek and the East Fork Poplar Creek.

Bear Creek. Bear Creek flows in a southwest direction from the Y-12 Plant through second-growth hardwood forests and late-successional old fields. At White Wing Road, Bear Creek turns northwest for the final 3.2 km (2 mi) of the approximately 11.3-km (7 mi) course, converging with East Fork Poplar Creek at kilometer 2.4 (mile 1.5). Stream width from Y-12 to the mouth of Bear Creek increases from 0.9 to 4.6 m (3 to 15 ft) and depth from 0.1 to 0.9 m (4 in to 3 ft). Bear Creek basin has a drainage area of 1917 ha (4736 acres). About 65 percent of the basin is wooded; the open land is mostly old fields. Several small perennial springs flow into Bear Creek from the limestone beds in the upper part of the Conasauga Formation and Knox Dolomite in Bear Creek Valley. Rome Formation occurs in the northern part of Bear Creek Valley. Residual soils in the valley consist of silt, sand, and coarse-textured material with small amounts of micaceous clay.

Stream habitat varies little as Bear Creek flows through Bear Creek Valley. The narrow stream flows over clay and rock substrate covered by precipitates and a floc of aluminum hydroxide (Oak Ridge Operations, 1975).

East Fork Poplar Creek. The headwaters of East Fork Poplar Creek originate on the northwestern slopes of Chestnut Ridge in the vicinity of the Y-12 Plant. Streamflow is controlled by New Hope Pond, approximately 2.0 ha (5.0 acres) on the east side of the Y-12 Plant which serves as a settling basin.

East Fork Poplar Creek below New Hope Pond is confined by 2.4-m (8-ft) high riprapped streambanks of limestone rock. Stream substrate also consists of limestone rocks with some interspersed gravel. Stream width varies from 3-4.6 m (10-15 ft).

East Fork Poplar Creek, after leaving the Y-12 Plant area, flows northwest through densely forested secondary-growth hardwoods. The predominant substrate is 2.5-10.2 cm (1-4 in) rocks. Stream width varies from 3.0-7.6 m (10-25 ft). Average stream gradient is about 4 m/km (21 ft/mi). At the Oak Ridge Turnpike (State Highway 95), East Fork Poplar Creek turns southwest and passes through several large pastures before entering hardwood forests (Oak Ridge Operations, 1975).

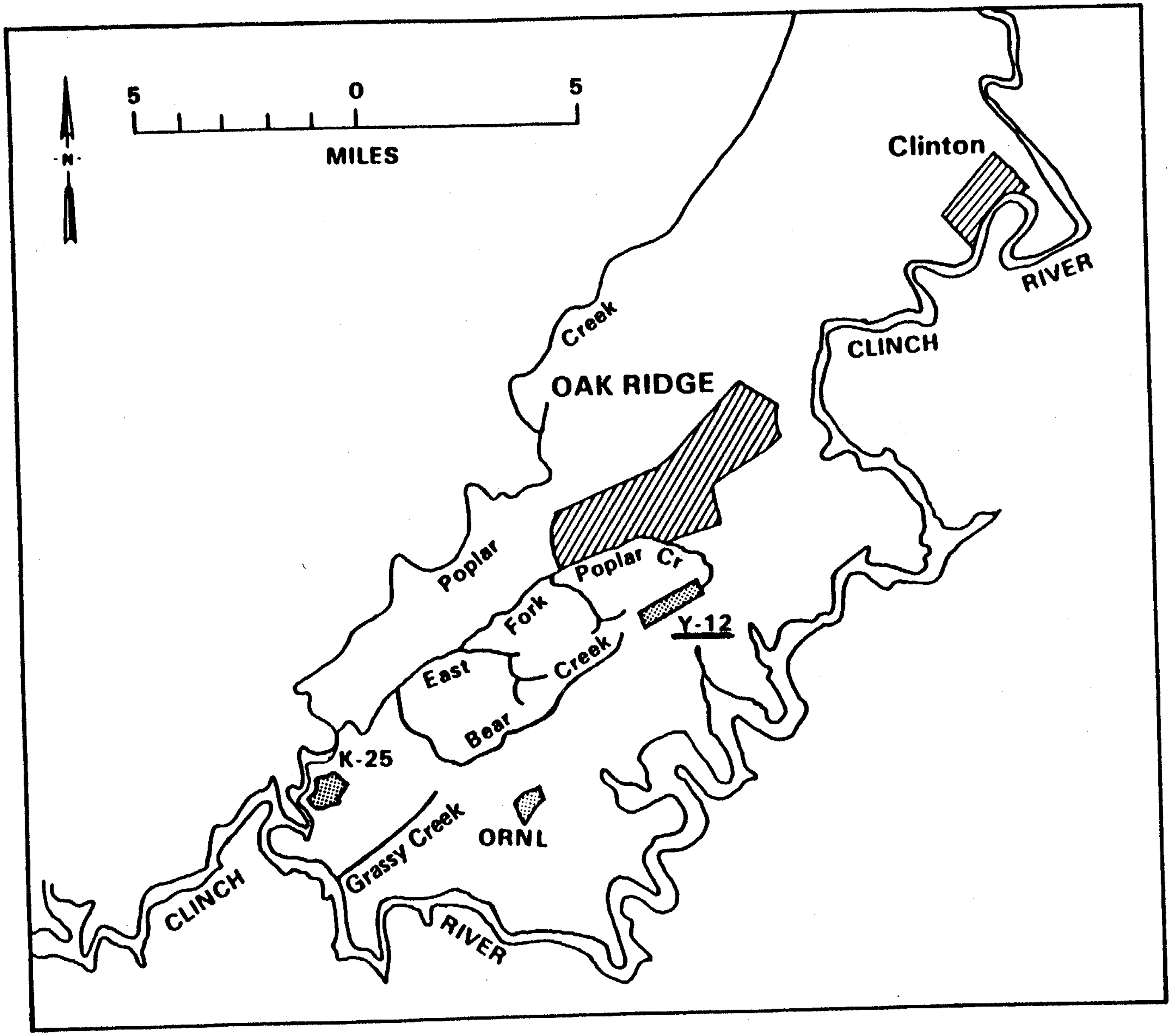

FIGURE III-9. RIVER AND STREAMS NEAR Y-12 PLANT.

Source: McMaster, 1967.

Clinch River. The Clinch River, which drains an area of 1,142,966 ha (2,824,320 acres), is the source of most water used in the Oak Ridge area. From it are drawn supplies for Clinton, Oak Ridge, and U.S. DOE facilities. Water pumped by the Oak Ridge pumping station is delivered to ORNL, Y-12, and the City of Oak Ridge. Wastewater from ORNL is returned to the Clinch River via White Oak Creek, from Y-12 via Bear Creek and East Fork Poplar Creek, and from the City of Oak Ridge via East Fork Poplar Creek and to the Clinch River at river kilometer 82 (mile 51). The Oak Ridge Gaseous Diffusion Plant also uses Clinch River water through two pumping stations. The water is returned to the Clinch River through Poplar Creek and directly to the river (McMaster, 1967).

River flow in the 48-km (30-mi) stretch along the south and west boundaries of the reservation is regulated principally at Melton Hill Dam. Melton Hill Reservoir extends approximately 69 km (43 mi) upstream. Flow below the Melton Hill Dam since 1963 has averaged 220,700 ℓ/sec (7,800 cfs). The maximum daily average release was 761,270 ℓ/sec (26,900 cfs) on March 16, 1973. Since the closure of the dam in 1963, there has been an average of 46 days per year on which no water was released from Melton Hill Dam (Oak Ridge Operations, 1975).

The Clinch River is a highly turbid, hardwater system, but water quality generally complies with Tennessee State water quality standards (Oak Ridge Operations, 1975).

III.E.2.b Groundwater

The volume of groundwater storage and discharge varies widely from aquifer to aquifer, according to rock type. In the Oak Ridge area, the Knox Dolomite is the major aquifer (water-bearing formation) and the shale and sandstone rocks of the Rome Formation are the poorest aquifers.

The groundwater table in the entire Oak Ridge Reservation can be described as a subdued replica of the surface topography. Thus, the groundwater flows from areas of high elevation to areas of low elevation and ultimately discharges into surface streams. This is characteristic of groundwater conditions in a humid region (Oak Ridge Operations, 1975).

The occurrence of water in the Knox Dolomite and in the Chickamauga Limestone is similar, although solution openings in the Chicamauga are generally smaller than those in the Knox.

In the sandstone and shale rocks of the area, that is, primarily those of the Rome Formation, of the Conasauga Group (which underlies most of Y-12), and of Pottsville age, water occurs in small openings along joints and bedding planes. Because the rocks are nearly insoluble, the openings are not substantially enlarged and the storage and transmissibility of these rocks are low (McMaster, 1967).

The thickness and characteristics of residual material overlying bedrock affect the occurrence of groundwater in the area. The residual material overlying the Conasauga is very similar in appearance to the unweathered bedrock but is less compact and water-bearing openings are larger. Consequently, the residue bears most of the groundwater in the Conasauga outcrop belt. Because the thickness of residue in these belts is, in most places, less than 9.1 m (30 ft), the volume of groundwater storage is small and virtually depleted by September or October (McMaster, 1967).

In view of the groundwater flow characteristics of the Knox Group and the Chickamauga Limestone, industrial facilities that are likely to release pollutants should not be located on these formations. The movement of groundwater through the formations is primarily in fractures that have been enlarged by solution. These channels have the ability to transport a pollutant over long distances with little opportunity for adsorption in a relatively short period of time (Oak Ridge Operations, 1975).

III.E.3 Flood Considerations

The Oak Ridge Reservation lies within the area under Tennessee Valley Authority Flood Control. As a flood control dam, Norris Dam (on the Clinch River upstream from the reservation) considerably reduces the Clinch River drainage area applicable to the reservation and, through controlled discharge in time of flood, greatly reduces potential flooding downstream. Controlled discharges at Melton Dam adjacent to the reservation at Clinch River Mile No. 23 and at the Watts Bar Dam on the Tennessee River downstream from the reservation also reduce the potential for flooding. Since the Oak Ridge area was acquired by the government in 1942, only minor flooding has occurred within the urban area of the City of Oak Ridge, which is no longer under government control. Some flooding of roads and low areas adjacent to East Fork Poplar Creek and the Clinch River within the current DOE Oak Ridge Reservation has occurred but virtually no damage to plant facilities has resulted. The Tennessee Valley Authority, however, has conducted studies relative to flooding within the area and these studies have been used in recent years to evaluate flood hazards in constructing new facilities and for land-use within the DOE Oak Ridge Reservation. The "regional flood," established by TVA and derived from consideration of the largest floods known to have occurred on streams whose watersheds have similar characteristics and are located in the same general geographic region as that of the Oak Ridge area, has been used in these evaluations. The effects on the DOE Oak Ridge Reservation of such a regional flood for the Clinch River, Poplar Creek, and East Fork Poplar Creek, based on regulation of discharges through Norris, Melton Hill and Watts Bar dams, are shown in Figure III-10. As observed in this figure, no major flooding is anticipated in the Y-12 area (Oak Ridge Operations, 1975). Available information indicates that the burial grounds are not in a flood plain.

III.E.4 Water Quality

The quality of the surface water in the vicinity of the Oak Ridge complex is monitored through the use of a network of stream sampling points and by

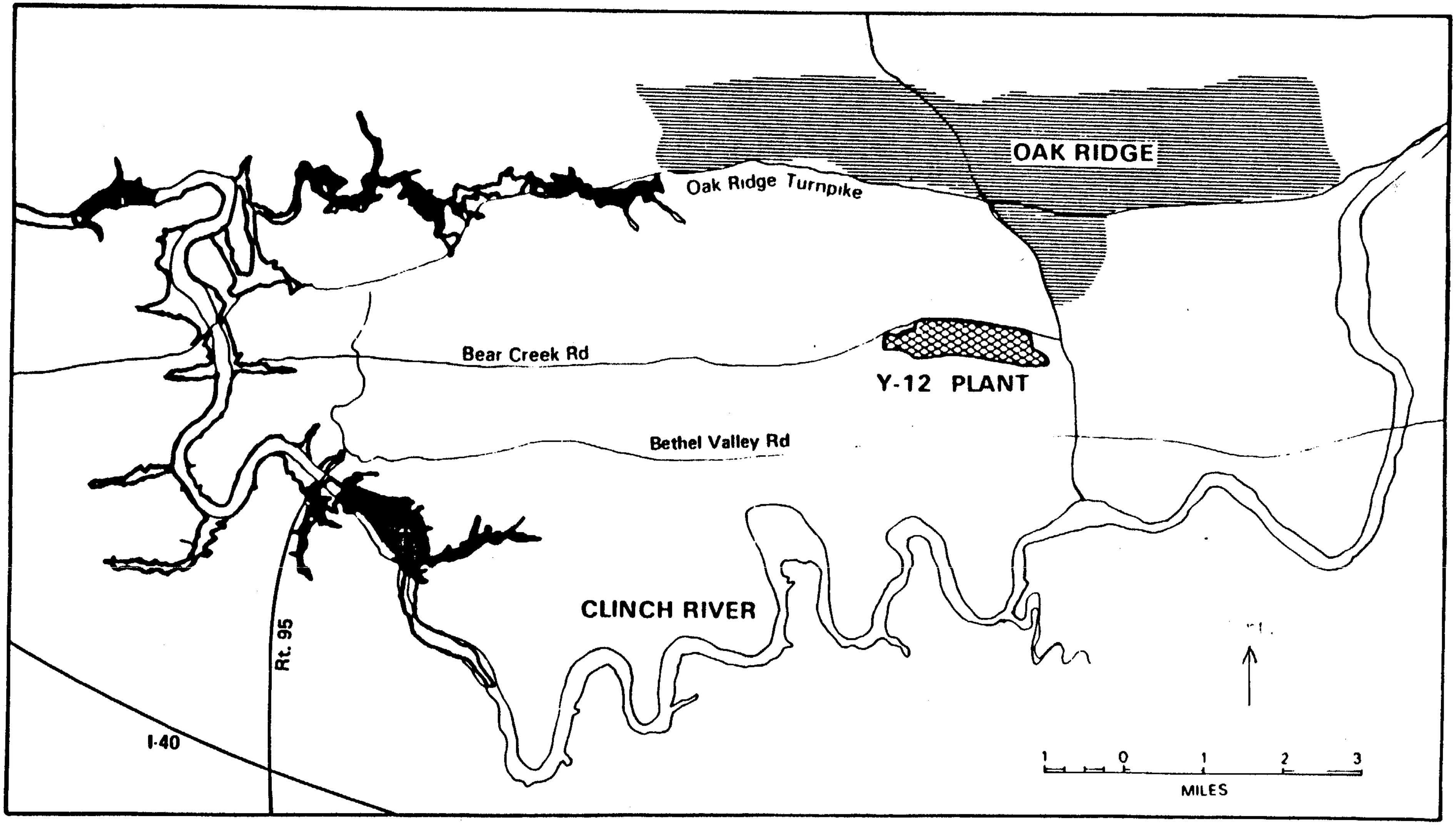

FIGURE III-10. FLOOD HAZARD POTENTIAL FOR AREA AROUND Y-12 PLANT.

Source: Oak Ridge Operations, 1975.

sampling the point source discharges into the streams. The stream samples are subjected both to radioactivity analyses and to chemical analyses. The effluent samples are analyzed for the parameters included in the National Pollutant Discharge Elimination Systems (NPDES) permit (Appendix A).

The stream sampling points for the Oak Ridge complex are shown in Figure III-11. Points B-1 and E-1 (Bear Creek and East Fork Poplar Creek) are the two points which reflect the effects of the activities of the Y-12 Plant on these streams.

III.E.4.a Radioactivity. An indication of the relatively low level of pollution by radioactive materials is provided by data in Table III-10 on the uranium concentration of East Fork Poplar Creek and of Bear Creek during 1978. In both cases the concentrations were less than the 0.1 percent of the concentration guide.

III.E.4.b Nonradioactive Pollutants. Surface water samples most directly related to the activities of the Y-12 Plant also are collected at points B-1 and E-1 for the determination of nonradioactive substances. The results of this monitoring program for CY 1978 are summarized in Tables III-11 and III-12, respectively. Comparisons of the chemical water quality at these points with Tennessee Stream Guidelines also are shown in these tables. These data show that the average concentrations of all substances analyzed were in compliance with Tennessee Stream Guidelines except for fluorides at the sampling point on East Fork Poplar Creek. At that point, the average fluoride concentration was 110 percent of the State stream guideline. In the opinion of the authors of the 1978 Environmental Monitoring Report, the primary source of the fluorides is the fluoridated water supply (1.0 mg/ℓ) from the Oak Ridge Water Treatment Plant. This situation serves to illustrate the consequenses of seemingly contradictory regulations set by various governmental agencies.

The NPDES permit for the Y-12 Plant requires monitoring and analysis of effluent samples from four outfalls or points:

- Kerr Hollow Quarry
- Bethel Valley Quarry
- New Hope Pond
- Bear Creek at the intersection of Route 95

The parameters and the effluent limits established by this permit as well as the percentages of measurements which were in compliance during 1978 are shown in Table III-13. As shown, 100 percent compliance was achieved at all four points for all parameters except for a 96 percent compliance for pH on the effluent from Bethel Valley Quarry and a 92 percent compliance on fluoride on the effluent from New Hope Pond.

III.E.5 Sensitive Areas

Since there are no sensitive areas (or scenic rivers) in the proximity of the Y-12 Plant, there is no influence on such areas.

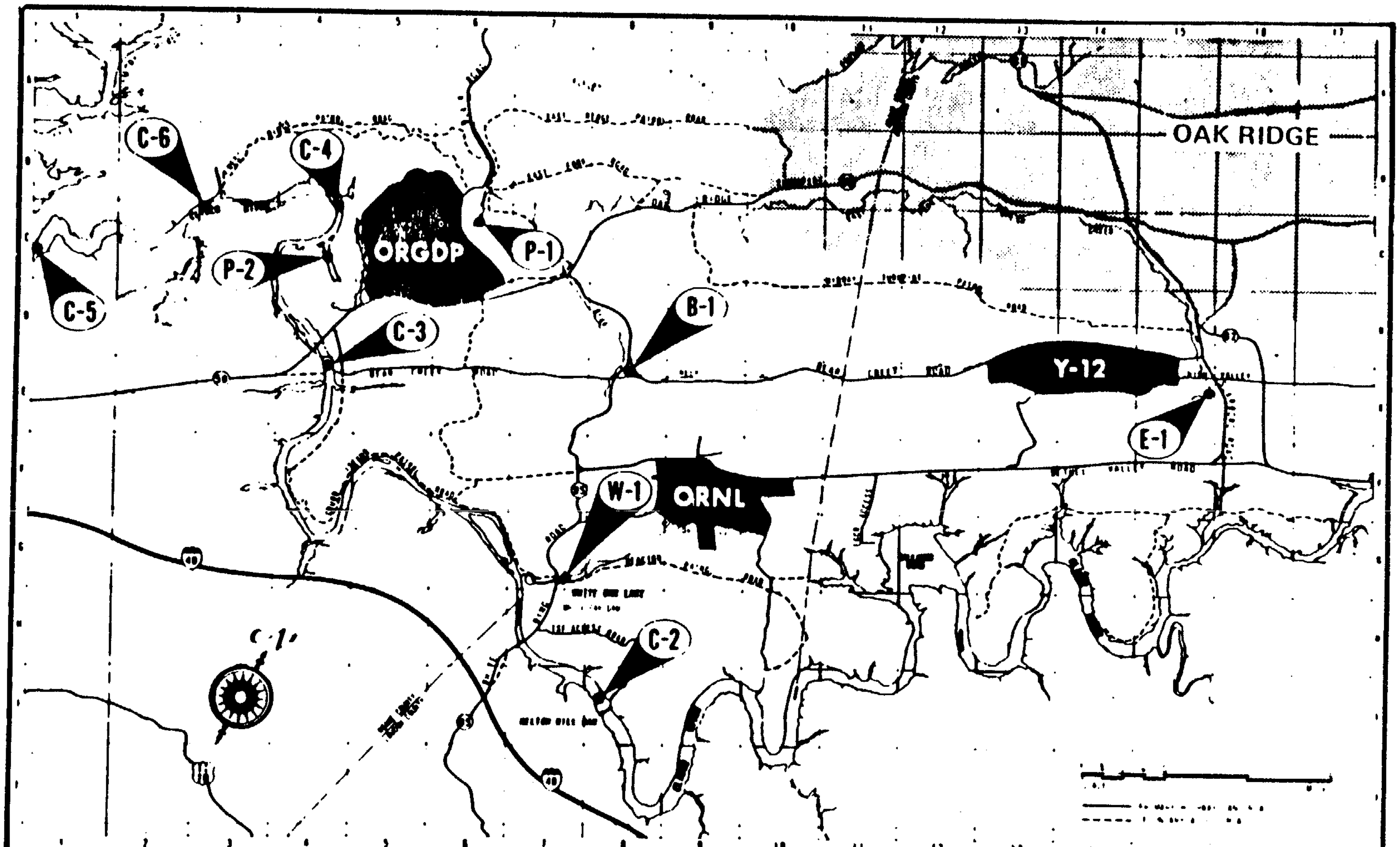

FIGURE III-11. STREAM MONITORING LOCATIONS

Source: Union Carbide, 1979

TABLE III-10. URANIUM CONCENTRATION IN SURFACE STREAMS, 1978

Station Number[a]	Location	Number of Samples	Units of 10^{-8} µCi/ml Maximum	Minimum	Average	% CG[b]
B-1	Bear Creek	12	3.1	1.4	1.8 ± 0.01	<0.1
E-1	East Fork Poplar Creek	12	1.9	0.5	1.1 ± 0.1	<0.1

(a) See Figure III-11

(b) Concentration Guide (CG) is 3 x 10^{-5} µCi/ml for a mixture of uranium isotopes (DOE Manual, Appendix 0524, Annex A, Table II).

*Source: Union Carbide, 1979.

TABLE III-11. CHEMICAL WATER QUALITY DATA - BEAR CREEK, 1978*
(Location B-1, Figure III-11)

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.003	< 0.002	< 0.002 ± 0.001	0.01	<20
Cl^-	12	8	3	5 ± 2	250	2
F^-	12	0.3	< 0.01	< 0.2 ± 0.03	1.0	<20
$NO_3(N)$	12	14	4	9 ± 2	10	90
$SO_4^=$	12	16	<10	<11 ± 1	250	< 5
Zn	12	0.04	< 0.02	< 0.02 ± 0.004	0.1	<20

[a]Tennessee Stream Guidelines.

*Source: Union Carbide, 1979.

TABLE III-12. CHEMICAL WATER QUALITY DATA - EAST FORK POPLAR CREEK, 1978* (Location E-1, Figure III-11)

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.01	< 0.002	< 0.003 ± 0.001	0.01	< 30
Cl^-	12	16	3	11.3 ± 2	250	4
Cr	12	0.05	< 0.01	< 0.02 ± 0.01	0.05	< 40
F^-	12	1.3	0.08	1.1 ± 0.01	1.0	110
Hg	12	0.002	< 0.0005	< 0.001 ± 0.0004	0.005	< 20
$NO_3(N)$	12	4	1	3 ± 0.6	10.0	30
Pb	12	0.01	< 0.01	< 0.01	0.05	< 20
$SO_4^=$	12	61	< 10	< 35 ± 8	250	< 14
T.D.S.	12	268	151	205 ± 20	500	41
Zn	12	0.03	< 0.02	< 0.02 ± 0.003	0.1	< 20

[a]Tennessee Stream Guidelines.

*Source: Union Carbide, 1979.

TABLE III-13. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) EXPERIENCE FOR THE Y-12 PLANT, 1978*

Discharge Point	Effluents Parameters	Effluent Limits: Daily Average, mg/l	Effluent Limits: Daily Maximum, mg/l	Percentage of Measurements in Compliance
	Y-12 Plant			
001 (Kerr Hollow Quarry)	Dissolved Solids	—	2000	100
	Lithium	—	5	100
	pH (pH units)	—	6.0–9.0	100
	Suspended Solids	—	50	100
	Zirconium	—	3	No Disposals
002 (Rogers Quarry)	pH (pH units)	—	6.0–9.0	96
	Suspended Solids[(a)]	30	50	100
	Settleable Solids (ml/l)[(a)]	—	0.5	100
003 (New Hope Pond)	Ammonia (N)	—	1.6	100
	Chromium	0.05	0.08	100
	Dissolved Oxygen (Min.)	5	—	100
	Dissolved Solids	—	2000	100
	Fluoride	1.5	2.0	92
	Lithium	—	5	100
	Oil and Grease	10	15	100
	pH (pH units)	—	6.0–9.0	100
	Phosphate (as MBAS)	5	8	100
	Suspended Solids[(a)]	—	20	100
	Settleable Solids (ml/l)[(a)]	—	0.5	100
	Total Nitrogen (N)	—	20	100
	Zinc	0.1	0.2	100
004 (Bear Creek)	Oil and Grease	10	15	100
	pH (pH units)	—	6.0–8.5	100

(a) Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface runoff resulting from precipitation.

*Source: Union Carbide, 1979.

III.F METEOROLOGY AND AIR QUALITY

III.F.1 Regional Overview

Oak Ridge's climate is of the humid continental type characterized by mild winters and hot summers with a moderate amount of precipitation evenly distributed throughout the year (Trewartha, 1968; Dickson, 1974). This portion of the country is generally under the influence of the western fringe of the semi-permanent Bermuda high pressure system. From spring until late summer, this high pressure system is located over the southeastern coast bringing warm and moist Gulf air to eastern Tennessee. During the other seasons, the system moves northward decreasing its influence over Tennessee (Exxon Nuclear Company, Inc., 1977). Pronounced local differences in wind and temperature are a function of topography (Swain, 1942).

Regional air quality is the product of local meteorology, terrain, land use, and emission sources (Canter, 1977). The predominance of high pressure systems restricts the dispersive capacity of the atmosphere. Consequently, eastern Tennessee has a high pollution potential (Exxon Nuclear Company, Inc., 1977). The Oak Ridge area (Anderson County) has been classified non-attainment for total suspended particulates because the national secondary ambient air quality standard is being violated. However, attainment status exists for sulfur dioxide. The area has not been classified for the remaining primary air pollutants, nitrogen oxides, carbon monoxide photochemical oxidants (ozone) and hydrocarbons (Federal Register, 1978a,b).

III.F.2 Meteorology

III.F.2.a Temperature. Table III-14 presents the mean monthly temperatures. They range from 3.4 C (38.1 F) in January to 25 C (77.0 F) in July. The highest temperature recorded has been 40.5 C (105 F) while the lowest has been -22.8 C (-9 F). Temperatures of 38 C (100 F) or higher are unusual, having occurred during less than one-half of the years of the period of record and temperatures of zero or less are rare. The average number of days between the last freeze of spring and the first killing frost is 200. Low-level temperature inversions occur during approximately 57 percent of the hourly observations. Fall is usually the season with the greatest number of hours of low-level inversion with the number decreasing progressively through spring and winter to summertime minimum, but seasonal differences are small.

III.F.2.b Precipitation. Winter and early spring are the seasons of greatest precipitation with monthly maximum normally occurring during January to March (Table III-14). A secondary maximum occurs in the month of July due to afternoon and evening thundershowers. September and October are usually the driest months. Precipitation is highly variable. Periods of five consecutive days without measurable precipitation occur about four or five times a year.

TABLE III-14. TEMPERATURE, RAINFALL, AND SNOWFALL DATA FOR THE OAK RIDGE, TENNESSEE AREA(a)

Month	Temperature(b)								Mean Rainfall		Mean Snowfall(c)	
	Mean		Highest			Lowest						
	°C	°F	°C	°F	Year	°C	°F	Year	cm	in	cm	in
January	3.4	38.1	23.9	75	(1952)	-22.8	-9	(1966)	13.34	5.25	8.38	3.3
February	4.7	40.4	26.1	79	(1977)	-18.3	1	(1965)	13.31	5.24	7.11	2.8
March	8.7	47.6	18.3	65	(1963)	-13.3	8	(1960)	13.84	5.45	3.81	1.5
April	14.7	58.4	32.8	91	(1970)	- 4.4	24	(1950)	10.69	4.21		Trace
May	19.3	66.7	33.9	93	(1962)	- 1.1	30	(1976)	8.94	3.52		0.0
June	23.4	74.2	38.3	101	(1954)	3.9	39	(1977)	10.01	3.94		0.0
July	25.0	77.0	40.5	105	(1952)	10.0	50	(1967)	14.40	5.67		0.0
August	24.5	76.1	37.8	100	(1954)	10.6	51	(1965)	9.78	3.85		0.0
September	21.2	70.1	38.9	102	(1954)	0.6	33	(1967)	8.48	3.34		0.0
October	15.1	59.1	32.2	90	(1954)	- 6.1	21	(1952)	6.91	2.72		Trace
November	8.4	47.1	28.3	83	(1961	-17.8	0	(1950)	10.29	4.05	1.02	0.4
December	4.0	39.2	23.3	74	(1951)	-19.4	-3	(1962)	13.61	5.36	5.08	2.0
Year	14.3	57.8	40.5	105	(1952)	-22.8	-9	(1966)	133.60	52.60	25.40	10.0

(a) Source: U.S. Department of Commerce, National Climatic Center, 1978.

(b) Length of record: 31 years.

(c) Include ice pellets.

Snow sometimes occurs in sufficient quantity to hinder or suspend traffic and outdoor activities. During the winter of 1959-60, a total of 105 cm (41.4 in) of snow fell, of which 53.3 cm (21.0 in) came in March. It is estimated that this unusually large amount of snowfall should occur with the frequency of approximately once in 100 years (Hilsmeier, 1963). The average snowfall from 1948-49 through 1977-78 is 24.4 cm (10.0 in) (Table III-14).

III.F.2.c Winds. The range of prevailing winds for the Oak Ridge area are usually either up-valley, from west to southwest, or down-valley, from east to northeast. During periods of light winds, daytime winds are usually southwesterly, nighttime winds usually northeasterly. Wind speeds are somewhat decreased by the mountains and ridges. Wind velocity data specific to the Y-12 Plant site are found in Table III-15; a graphic display is provided in Figure III-12. Winds in the Y-12 area are similar to winds in other sites in the Oak Ridge area. The average wind speed in the Oak Ridge area is 7.0 kmph (4.3 mph). Winds as high as 95 kmph (59 mph) have been recorded.

III.F.2.d Severe Storms. Thunderstorms which strike the Oak Ridge area can precipitate other weather hazards. The frequency of thunderstorms for the Oak Ridge area are presented in Figure III-13 and Table III-16. Tornados rarely occur in the Oak Ridge area (U.S. Department of Commerce, National Climatic Center, 1978), but it is subjected to frequent hailstorms (Figure III-14).

III.F.3 Air Quality

Atmospheric concentrations of pollutants in the vicinity of the Oak Ridge facility are monitored by a network of ambient sampling stations. The monitoring stations sample radioactive and nonradioactive emissions. For radioactive emissions, there are two systems of monitoring stations. One system consists of nine stations (HP-31 through HP-39) which encircle the Oak Ridge area and provide data for evaluating releases from Oak Ridge facilities to the immediate environment (Figure III-15). A second system consists of eight stations (HP-51 through HP-58) encircling the Oak Ridge area at distances from 19 to 121 kilometers (12 to 75 miles) (Figure III-16). This system provides background data. For nonradioactive emissions monitoring stations sample fluorides, suspended particulates, and sulfur dioxide. Sampling locations for fluorides are indicated by F1-F6, for suspended particulates by SP1-SP4, and for sulfur dioxide by S1 and S2 in Figure III-15.

III.F.3.a Radioactivity. The quantities of radioactive material released to the atmosphere and the concentrations of radioactive materials in the air in the Oak Ridge and surrounding areas are presented in Tables III-17 through III-20 (Union Carbide, 1979). The average gross beta concentration of radioactivity from particulates in the air, measured by the perimeter and remote monitoring stations were 0.07 and 0.08 percent, respectively, from the applicable concentration guide (Table III-17). The average gross alpha concentration in the perimeter and remote monitoring stations was 0.03 percent of the concentration guide (Table III-18).

TABLE III-15. WIND VELOCITY DATA FOR THE OAK RIDGE AREA[a]

Month	Wind Speeds: Mean km/h	Mean mph	Prevailing Direction	Fastest Mile km/h	Fastest Mile mph	Year
January	7.7	4.8	SW	94.9	59	1959
February	8.0	5.0	ENE	75.6	47	1967
March	8.5	5.3	SW	77.2	48	1962
April	9.2	5.7	SW	80.5	50	1959
May	7.2	4.5	SW	74.0	46	1973
June	6.8	4.2	SW	80.5	50	1975
July	6.3	3.9	SW	80.5	50	1961
August	6.0	3.7	E	85.3	53	1964
September	6.1	3.8	E	61.2	38	1959
October	5.8	3.6	E	62.8	39	1967
November	6.6	4.1	E	72.4	45	1968
December	7.2	4.5	SW	80.5	50	1964
Year	7.1	4.4	SW	94.9	59	January 1959

(a) Source: U.S. Department of Commerce, National Climatic Center, 1978.

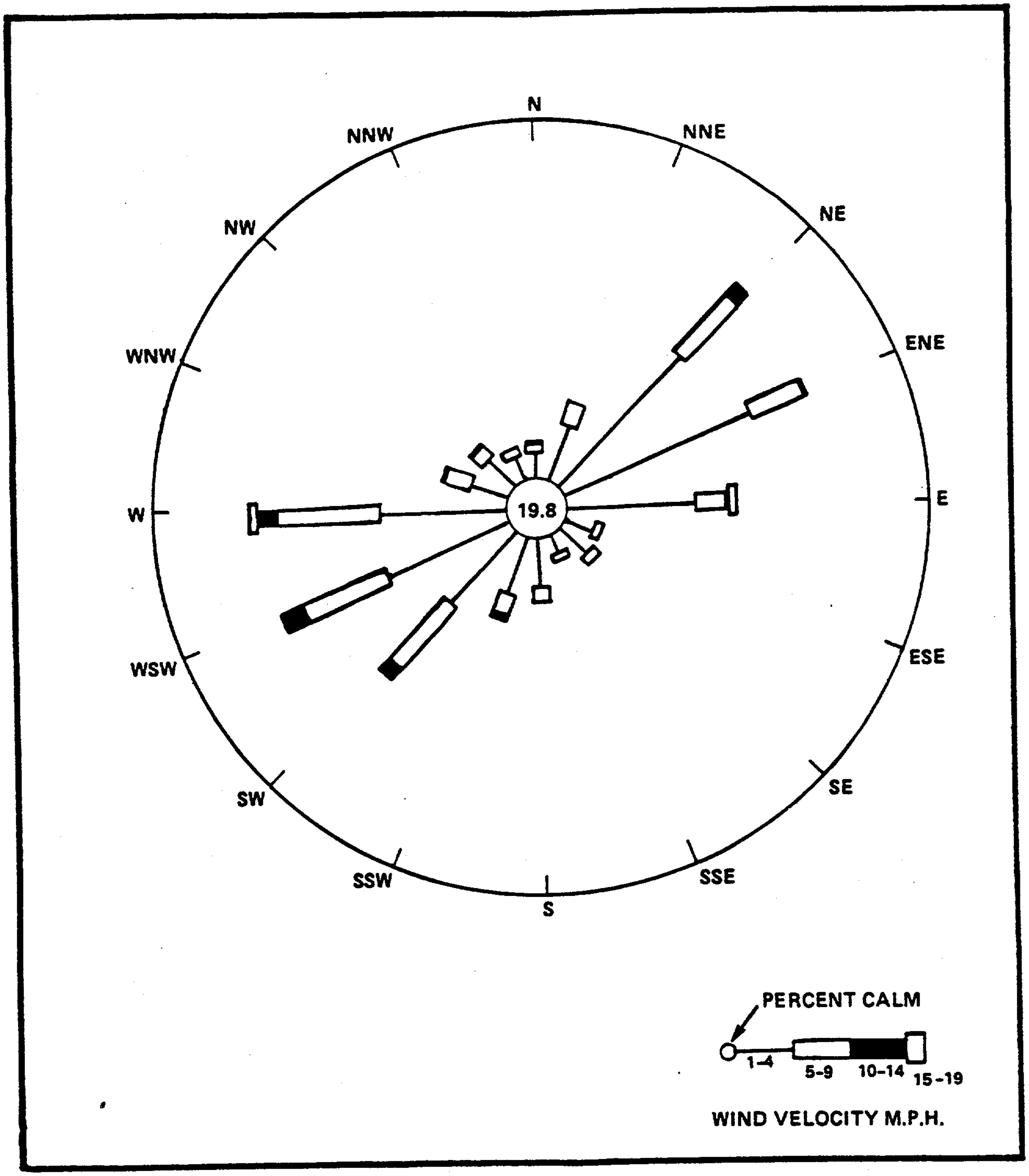

FIGURE III-12. WIND ROSE FOR THE Y-12 PLANT

Source: Alexander,1979

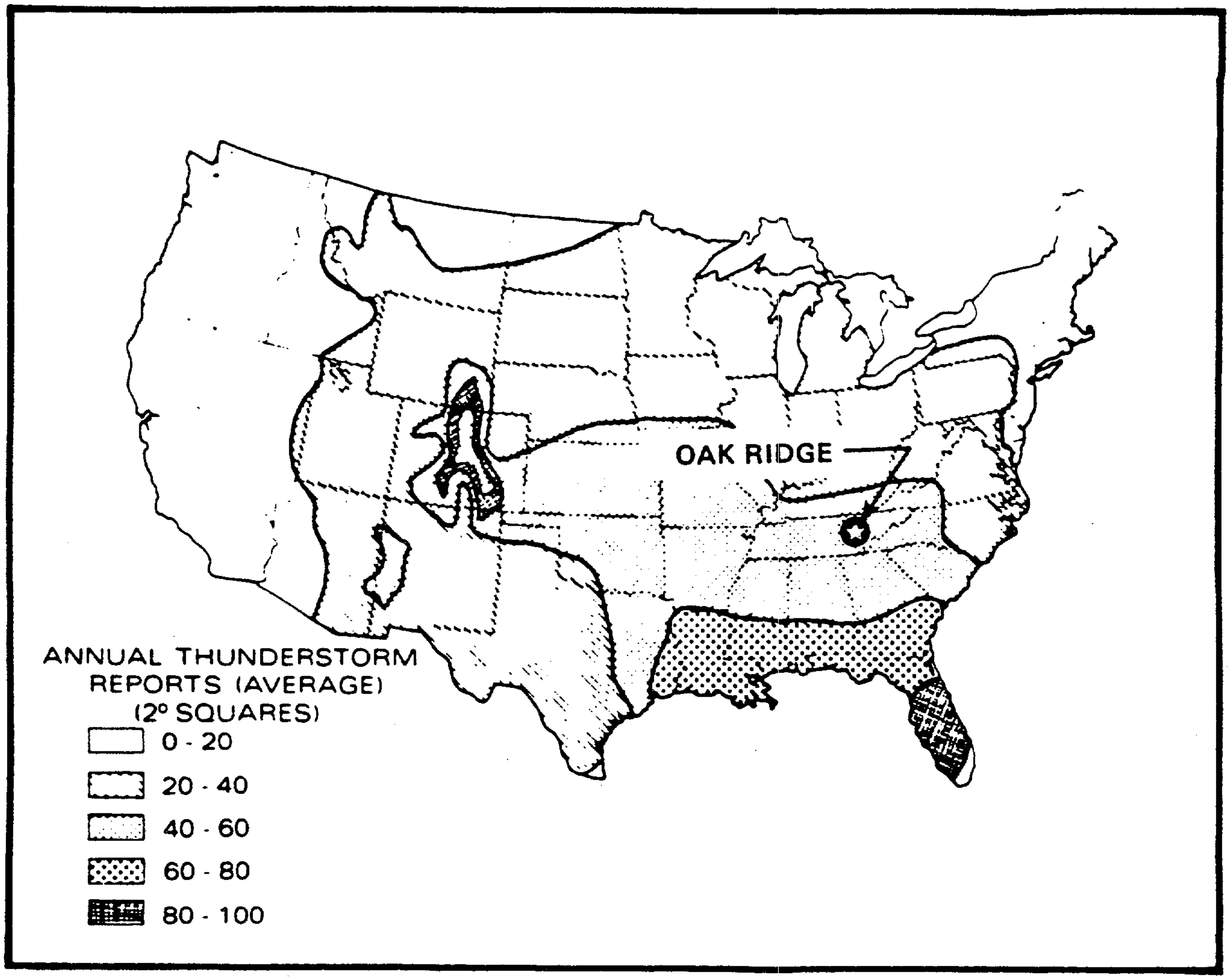

FIGURE III-13. THUNDERSTORM RISK MAP

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1973

TABLE III-16. OAK RIDGE CLIMATE SUMMARY (IN MEAN NUMBER OF DAYS)[a]

Month	Clear	Partly Cloudy	Cloudy	Rain*	Snow**	Thunder-storms	Heavy Fog***
January	7	6	18	13	1	1	1
February	8	5	15	11	1	2	1
March	8	6	17	13	0	3	1
April	9	7	14	11	0	5	1
May	10	8	13	11	0	8	2
June	9	10	11	11	0	9	2
July	8	11	12	12	0	11	3
August	10	10	11	10	0	9	4
September	10	8	12	8	0	3	4
October	14	6	11	8	0	1	8
November	9	6	15	10	0	1	6
December	8	5	18	11	1	1	2
Year	110	88	167	128	3	53	34

[a]Source: U.S. Department of Commerce, National Climatic Center, 1978.

* 0.01 inch or more.
** Snow, ice pellets: 1.0 inch or more.
*** Visibility 1/4 mile or less.

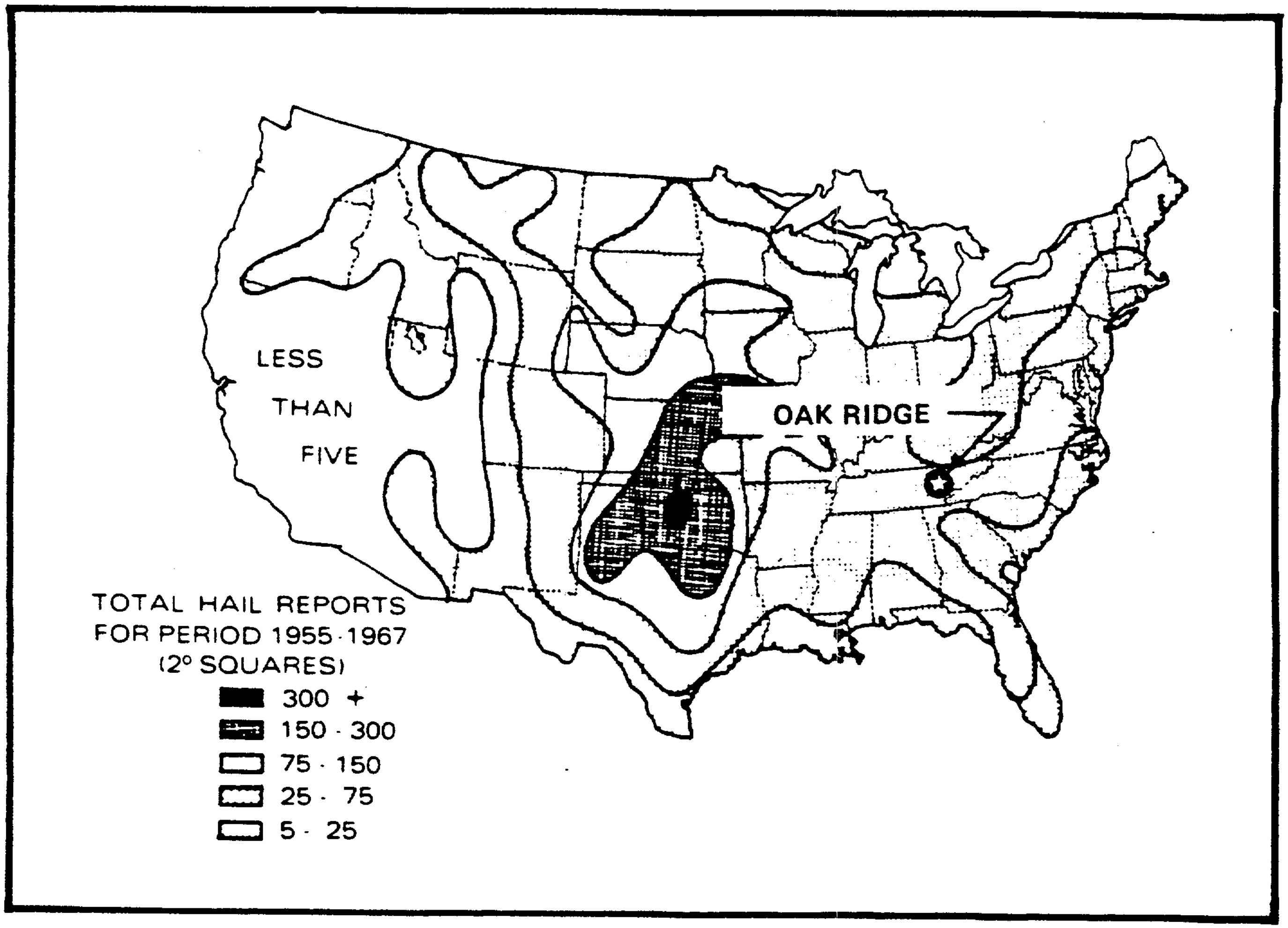

FIGURE III-14. HAILSTORM FREQUENCY MAP. DATA COVER ONLY HAILSTONES 3/4-INCH AND LARGER

Source: U.S. Department of Commerce, Environmental Science Service Administration, 1969

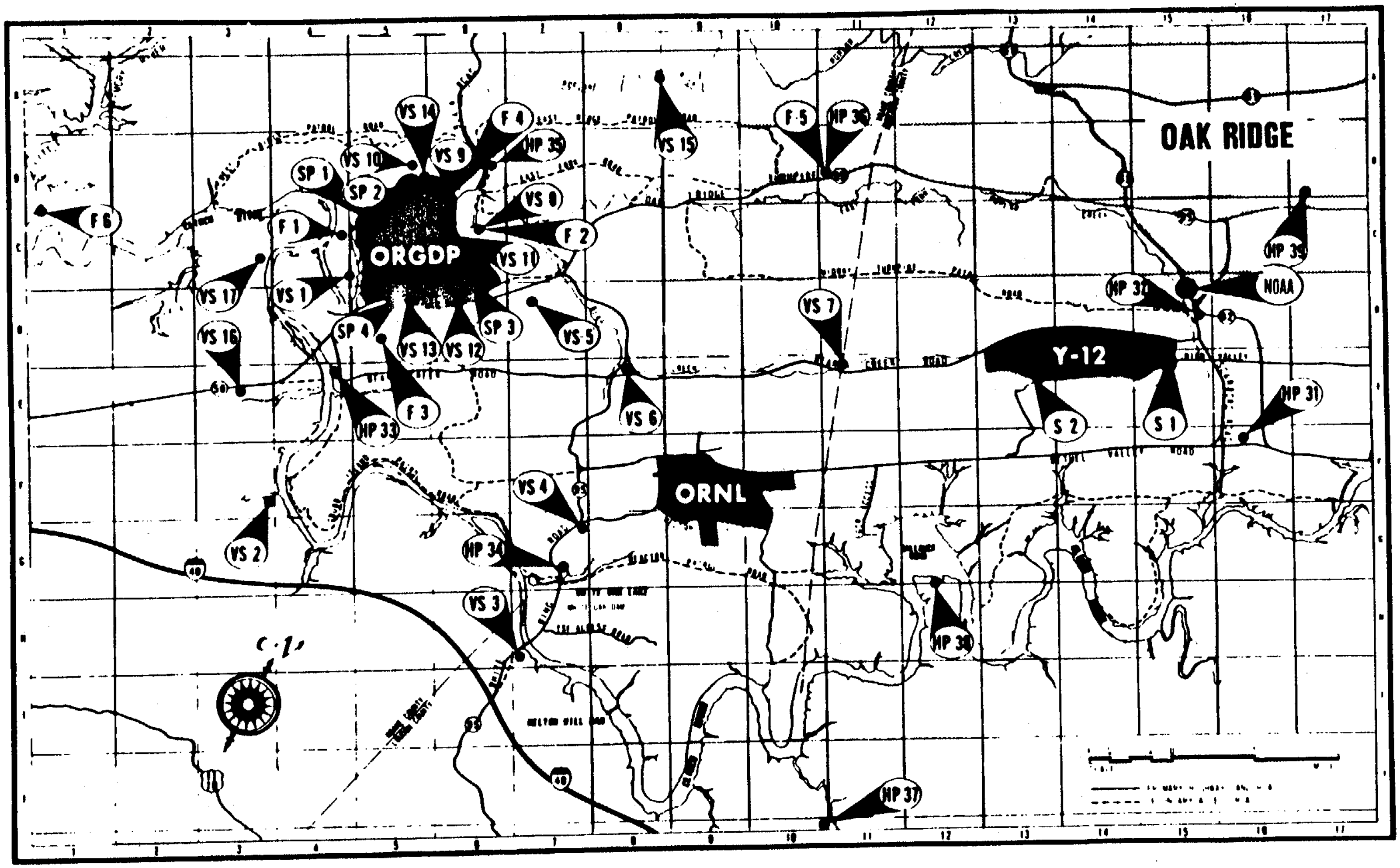

FIGURE III-15. AIR SAMPLING LOCATIONS

Vegetation samples are also collected at locations identified by VS.

Source: Union Carbide, 1979

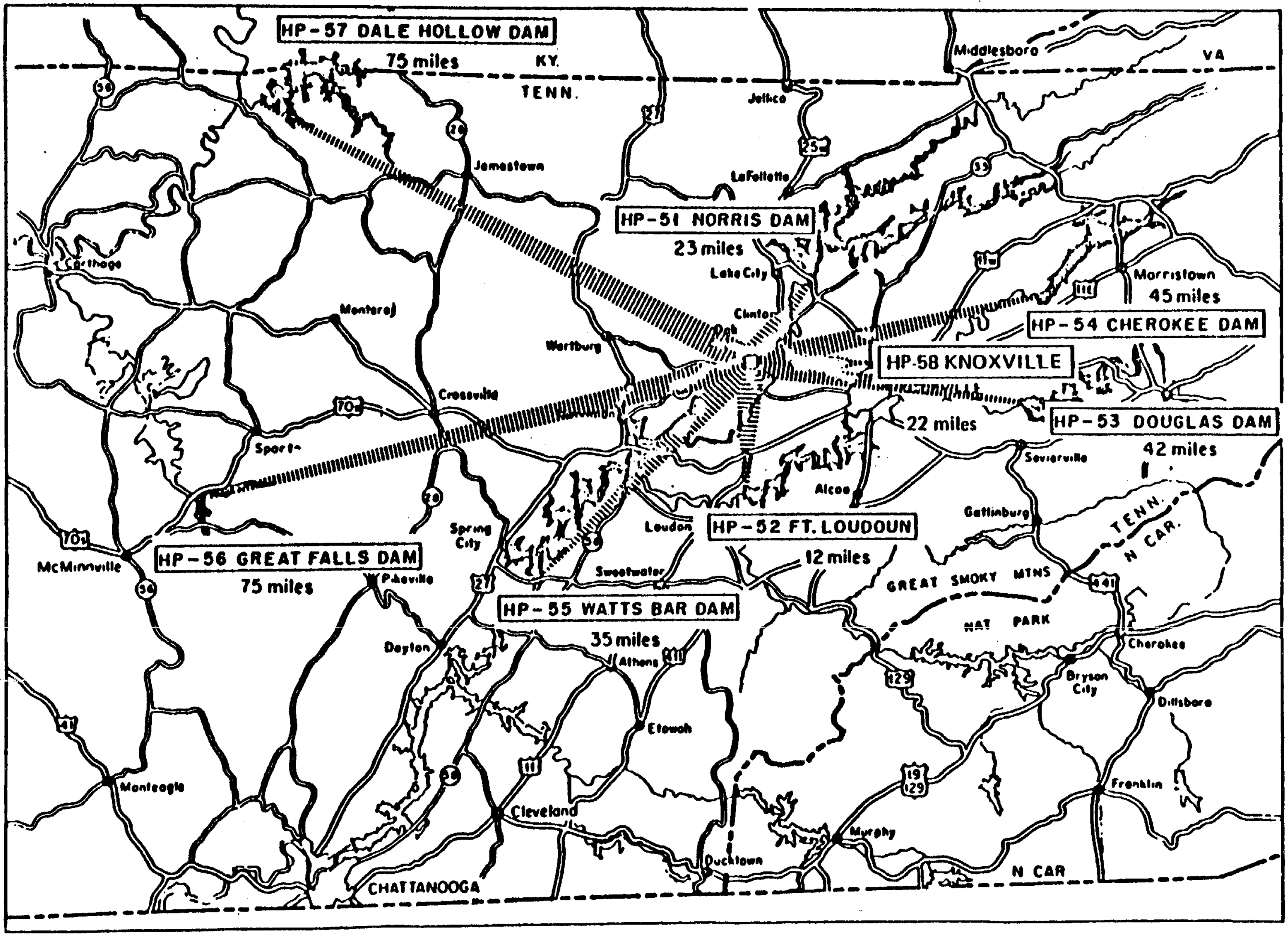

FIGURE III-16. STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Source: Union Carbide, 1979.

TABLE III-17. CONTINUOUS AIR MONITORING DATA (Long-lived gross beta activity of particulates in air, 1978)*

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-13} µCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
		Perimeter Area[d]				
HP-31	Kerr Hollow Gate	52	1.3	0.12	0.48 ± 0.08	0.05
HP-32	Midway Gate	51	10.4	0.18	0.83 ± 0.40	0.08
HP-33	Gallaher Gate	51	6.4	0.02	0.56 ± 0.24	0.06
HP-34	White Oak Dam	52	10.9	0.17	0.84 ± 0.42	0.08
HP-35	Blair Gate	51	1.6	0.01	0.59 ± 0.12	0.06
HP-36	Turnpike Gate	52	9.0	0.09	0.68 ± 0.34	0.07
HP-37	Hickory Creek Bend	52	8.0	0.09	0.61 ± 0.30	0.06
HP-38	East of EGCR	50	10.1	0.08	0.78 ± 0.39	0.08
HP-39	Townsite	52	10.8	0.17	0.79 ± 0.40	0.08
Average					0.68 ± 0.11	0.07
		Remote Area[e]				
HP-51	Norris Dam	52	10.2	0.08	0.78 ± 0.38	0.08
HP-52	Loudoun Dam	50	12.1	0.10	0.80 ± 0.48	0.08
HP-53	Douglas Dam	52	11.3	0.08	0.75 ± 0.42	0.08
HP-54	Cherokee Dam	52	11.9	0.08	0.75 ± 0.44	0.08
HP-55	Watts Bar Dam	52	15.0	0.01	0.57 ± 0.58	0.06
HP-56	Great Falls Dam	50	13.7	0.04	0.80 ± 0.53	0.08
HP-57	Dale Hollow Dam	52	12.3	0.04	0.92 ± 0.46	0.09
HP-58	Knoxville	52	10.5	0.01	0.67 ± 0.40	0.07
Average					0.75 ± 0.16	0.08

*Source: Union Carbide, 1979.

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 3×10^{-8} µCi per sample.

[c]CG is 10^{-10} µCi/ml for unidentified radionuclides (DOE Manual, Appendix 0524, Annex A, Table 11).

[d]See Figure III-15.

[e]See Figure III-16.

TABLE III-18. CONTINUOUS AIR MONITORING DATA (Long-lived gross alpha activity of particulates in air, 1978).*

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-15} µCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
			Perimeter Area[d]			
HP-31	Kerr Hollow Gate	52	2.9	0.5	1.1 ± 0.2	0.03
HP-32	Midway Gate	51	4.1	0.7	1.4 ± 0.2	0.04
HP-33	Gallaher Gate	51	3.7	0.5	1.1 ± 0.2	0.03
HP-34	White Oak Dam	52	3.1	0.5	1.0 ± 0.2	0.03
HP-35	Blair Gate	51	40.9	<0.1	<2.2 ± 0.2	<0.06
HP-36	Turnpike Gate	52	4.2	0.5	1.1 ± 0.2	0.03
HP-37	Hickory Creek Bend	52	2.9	0.3	0.9 ± 0.2	0.02
HP-38	East of EGCR	50	3.5	0.5	1.1 ± 0.2	0.03
HP-39	Townsite	52	3.4	0.6	1.1 ± 0.2	0.03
Average					<1.2 ± 0.1	<0.03
			Remote Area[e]			
HP-51	Norris Dam	52	1.8	0.5	0.9 ± 0.1	0.02
HP-52	Loudoun Dam	50	1.8	0.5	0.8 ± 0.1	0.02
HP-53	Douglas Dam	52	3.3	0.5	1.2 ± 0.2	0.03
HP-54	Cherokee Dam	52	2.3	<0.1	<0.9 ± 0.1	<0.02
HP-55	Watts Bar Dam	52	3.8	<0.1	<0.9 ± 0.2	<0.02
HP-56	Great Falls Dam	52	3.5	0.5	0.9 ± 0.2	0.02
HP-57	Dale Hollow Dam	52	2.5	0.5	1.0 ± 0.1	0.03
HP-58	Knoxville	52	2.8	0.5	1.0 ± 0.2	0.06
Average					<1.0 ± 0.1	<0.03

*Source: Union Carbide, 1979.

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 2 x 10^{-6} µCi per sample.

[c]CG is 40 x 10^{-13} µCi/ml for a mixture of uranium isotopes. (DOE Manual, Appendix 0524, Annex A, Table 11).

[d]See Figure III-15.

[e]See Figure III-16.

TABLE III-19. CONTINUOUS AIR-MONITORING DATA
Specific Radionuclides in Air[(a)]
(Composite Samples)
1978
Units of 10^{-15} μCi/ml[(b)]

RADIONUCLIDE	PERIMETER STATIONS 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average	REMOTE STATIONS 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average
^{7}Be	110	120	103	92.5	106	115	125	89.3	73.5	100.7
^{54}Mn	0.20	0.26	0.051	0.025	0.13	0.17	0.29	ND	0.025	0.16
^{90}Sr	1.49	1.25	0.27	0.21	0.81	1.6	0.85	0.44	0.22	0.78
^{95}Zr	6.9	1.7	0.25	ND*	2.95	7.4	1.9	0.20	ND	3.2
^{95}Nb	16.7	10.2	0.86	ND	9.25	17.6	10.5	0.71	0.15	7.24
^{103}Ru	47.3	ND	ND	ND	47.3	51.7	1.2	ND	ND	26.5
^{106}Ru	14.8	17.3	4.9	1.8	9.7	15.3	18.1	4.4	1.75	9.89
^{125}Sb	2.2	2.7	0.81	0.25	1.49	2.0	2.8	0.71	0.25	1.44
^{137}Cs	2.7	4.0	1.32	0.55	2.14	2.8	4.2	1.2	0.48	2.17
^{141}Ce	36.9	0.51	ND	0.5	12.6	39.8	ND	ND	0.35	20.1
^{144}Ce	23.2	29.1	7.6	2.35	15.6	23.9	31.6	7.1	2.2	16.2
^{228}Th	< 0.0027	0.013	0.012	0.012	< 0.0093	< 0.0051	0.0047	0.014	0.012	< 0.0089
^{230}Th	0.0044	0.12	0.012	0.010	0.0366	0.0020	0.0079	< 0.00011	0.010	< 0.0050
^{232}Th	< 0.0018	0.0035	0.0068	0.0039	< 0.004	0.00077	0.0029	0.068	0.0039	0.019
^{234}U	0.37	0.34	0.42	0.70	0.46	0.16	0.036	0.0053	0.70	0.23
^{235}U	0.029	0.029	0.022	0.035	0.029	0.0061	0.0037	0.089	0.035	0.033
^{238}U	0.26	0.22	0.34	0.33	0.29	0.12	0.23	0.0073	0.033	0.098
^{238}Pu	0.00044	0.00093	0.00092	0.000091	0.00060	0.00051	0.00092	0.0089	0.00070	0.0028
^{239}Pu	0.012	0.043	0.014	0.0065	0.019	0.032	0.040	0.011	0.0048	0.068

*Not detectable.

(a) The only radioactive material currently associated with Y-12 Plant operations is uranium. The uranium values presented are a composite of Y-12, K-25, and ORNL emissions.

(b) Source: Union Carbide, 1979.

TABLE III-20. DISCHARGES OF RADIOACTIVITY TO THE ATMOSPHERE 1978[a]

Radionuclide	Curies Discharged
Uranium[b]	0.03[c]
Alpha[d]	$<2 \times 10^{-8}$

(a) Source: Union Carbide, 1979.

(b) Uranium of varying enrichments-curie quantities calculated using the appropriate specific activity for material released.

(c) Uranium is the only isotope associated with Y-12 Plant operations. The uranium value presented is a composite of Y-12 and K-25 emissions.

(d) Unidentified alpha.

Although some radioactivity was released to the atmosphere, measurements in the Oak Ridge area indicate that environmental levels were below established standards (Union Carbide, 1979). Larger releases of radioactivity could occur as the result of accidents which could occur during normal plant operations. To evaluate the effects of such an accident, it was assumed that despite numerous mitigating equipment, a fire could occur in an air filtering system associated with a facility which processes enriched uranium. A conservative estimate of 5 kilograms was assumed to be contained on the filters and that all this material would be carried into the atmosphere. A plume analysis, based on conservative atmospheric conditions indicated that the uranium could be dispersed into the residential area of Oak Ridge. At the closest residence, about one-half mile north of the accident site, individuals could have an exposure of as much as 0.02 rem or 13 percent of the permissible exposure for the general public as given in DOE Order 5480.1, Change 2.

III.F.3.b Nonradioactive Emissions. The results of the air monitoring for suspended particulates, sulfur oxides, and fluorides for calendar year 1978 are presented in Tables III-21, 22, and 23. The average concentrations of suspended particulates and sulfur dioxides were in compliance with applicable standards during calendar year 1978. The maximum concentration of fluorides over a 7-day averaging period at four fluoride monitoring stations within the Y-12 Plant during 1978 (Figure III-17) are presented in Table III-23. The Tennessee Air Pollution Control Regulations fix the maximum concentration of this pollutant at 1.6 $\mu g/m^3$ for a 7-day averaging interval. The highest level experienced during 1978 was at location F-2 in September, when the ambient fluoride level reached 15 percent of the state standard. A similar situation occurred in March at location F-3 when the ambient fluoride level was about 13 percent of the state standard. All of the other levels are considerably lower.

Other emissions of nonradioactive chemicals could result from accidental releases. Three potential accidents were evaluated to determine the effects of such releases. These accidents were; a fire in a building which contains several thousand pounds of residual mercury in unused process equipment, the release of the contents of a 850-pound hydrogen fluoride cylinder after the accidental breaking of the cylinder valve, and a spill of 1,200 pounds of sulfuric acid during a transfer operation.

In the case of the fire in the building containing mercury, it was assumed that all the mercury would be vaporized. Using a conservative plume analysis, mercury concentrations as high as 5.6 mg/m^3 were calculated at the closest residences in Oak Ridge. This concentration exceeds mercury standards but is considerably less than the 28 mg/m^3 level set by OSHA as being immediately dangerous to life and health.

In the case of the hydrogen fluoride release, it was assumed that the contents of the cylinder would be released in 20 minutes. Using a conservative plume analysis, concentrations as high as 17 mg/m^3 were calculated at the closest residences in Oak Ridge. This concentration exceeds standards for hydrogen fluoride but is less than the 20 mg/m^3 set by OSHA as being immediately hazardous to life and health.

TABLE III-21. AIR MONITORING DATA - SUSPENDED PARTICULATES* 1978

LOCATION[a]	NUMBER OF SAMPLES	CONCENTRATION, $\mu g/m^3$			% STD.[b]
		MAXIMUM	MINIMUM	AVERAGE	
SP-1	45	322	2	38 ± 30	51
SP-2	45	387	8	35 ± 33	46
SP-3	44	259	9	37 ± 28	48
SP-4	41	240	9	42 ± 32	56

[a]See Figure III-15.

[b]Tennessee Air Pollution Control Regulations - Primary standard based on annual geometric mean is 75.0 $\mu g/m^3$.

*Source: Union Carbide, 1979.

TABLE III-22. SULFUR DIOXIDE MONITORING DATA, 1978*

MONTH	MAXIMUM 24 HR. AVERAGE (PPM)		MONTHLY AVERAGE (PPM)	
	STATION S-1	STATION S-2	STATION S-1	STATION S-2
January	.02	.09	.011	.033
February	No Data	.09	No Data	.036
March	No Data	.03	No Data	.017
April	.01	.01	.012	.009
May	.02	No Data	.007	No Data
June	.02	No Data	.018	No Data
July	.01	.04	.010	.015
August	.01	.02	.006	.012
September	.03	.04	.008	.022
October	.01	.10	.008	.025
November	.01	.04	.007	.038
December	.01	.22*	.006	.055*
Annual Arithmetic Mean			.009	.026

Tennessee Ambient Standards
Maximum 24 hr. Average -0.14 ppm
Annual Arithmetic mean -0.03 ppm
Minimum Detectable Limit -0.005 ppm

*System calibration in question.

Source: Union Carbide, 1979.

TABLE III-23. FLUORIDES - AIR MONITORING DATA FOR 1978

Month	Location	Maximum Concentration 7 Day Interval µg/m³	Fraction of Standard[(a)]
January	F-1	.06	.0375
	F-2	.36	.225
	F-3	.07	.0438
	F-4	.035	.0219
February	F-1	.04	.025
	F-2	.07	.0438
	F-3	<.004	<.0025
	F-4	.07	.0438
March	F-1	<.004	<.0025
	F-2	.12	.075
	F-3	.21	.1313
	F-4	.07	.0438
April	F-1	<.004	<.0025
	F-2	<.004	<.0025
	F-3	.12	.075
	F-4	.01	.0063
May	F-1	.02	.0125
	F-2	.01	.0063
	F-3	<.004	<.0025
	F-4	<.004	<.0025
June	F-1	.11	.0688
	F-2	.05	.0313
	F-3	.01	.0063
	F-4	<.004	<.0025
July	F-1	.02	.0125
	F-2	<.004	<.0025
	F-3	<.004	<.0025
	F-4	<.004	<.0025
August	F-1	<.004	<.0025
	F-2	<.004	<.0025
	F-3	<.004	<.0025
	F-4	<.004	<.0025
September	F-1	.01	.0063
	F-2	.24	.15
	F-3	.01	.0063
	F-4	.01	.0063
October	F-1	.02	.0125
	F-2	.07	.0438
	F-3	.01	.0063
	F-4	<.004	<.0025
November	F-1	.02	.0125
	F-2	.04	.025
	F-3	<.004	<.0025
	F-4	<.004	<.0025
December	F-1	.01	.0063
	F-2	.12	.075
	F-3	<.004	<.0025
	F-4	<.004	<.0025

(a) Tennessee Air Pollution Control Regulations 1.6 µg/m³ for 7 day averaging interval

Source: Alexander, 1979.

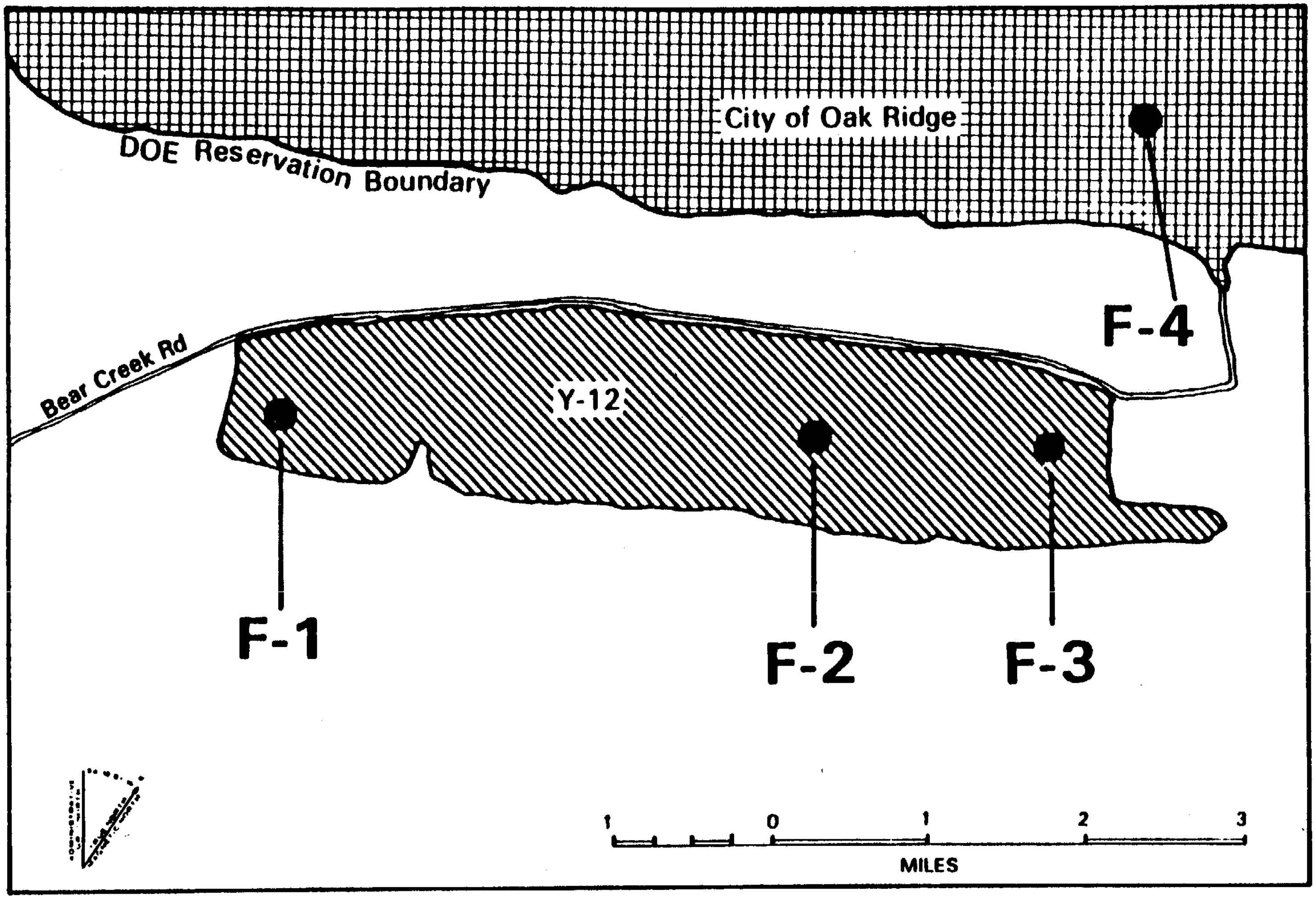

FIGURE III-17. Y-12 FLUORIDE AIR SAMPLING STATIONS

Source: Alexander, 1979.

In the case of the sulfuric acid spill, the acid would drain to the storm sewer system and flow to the New Hope Pond at the east end of the plant. The water entering the pond would have a pH of 1. Assuming that the pond containment system failed to operate, the water leaving the pond would have a pH of 4. This pH would kill fish and other organisms in the creek for several miles downstream. Since the stream flows through the city of Oak Ridge, the effects of the spill would be noted. These effects would be temporary, and the organisms in the creek would recover.

III.G BIOLOGY

III.G.1 Regional Overview

The Y-12 Plant lies within the boundaries of the Temperate Deciduous Forest biome (Weaver and Clements, 1929; Oosting, 1956; Shelford, 1974; Bailey, 1976 and 1978). A predominance of tall, broadleafed trees characterizes the region's pristine or natural vegetation. In summer, these trees provide a continuous, dense canopy but shed their foliage completely each fall. A well-developed understory of trees and shrubs exists and they are layered into distinct vertical strata. However, lower layers of small trees and shrubs develop weakly. Although a luxuriant low layer of herbs develops quickly each spring, it is greatly reduced after the trees reach full foliage and shade the ground. Dense litter consisting of fallen branches and abscised leaves covers the forest floor. Dominant and influent mammals include the whitetail deer, red and gray fox, bobcat, raccoon, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole, short-tailed shrew, and cotton mouse. Bird populations are large and most of the small birds do not reside in the forest throughout the year. Common birds include woodpeckers, bobwhite, cardinal, tufted titmouse, wood thrush, and summer tanager. Box turtle, common garter snake, and timber rattlesnake are characteristic reptiles. Amphibians are represented by the slimy salamander (Shelford, 1974; Bailey, 1978).

III.G.2 Flora

Vegetation types are used to designate assemblages of plants in a given area and, on a large geographical scale, are delineated by regions of similar climate. Thus, vegetation in any one locality is composed of competing species with similar ecological requirements. Separation of vegetation into types can be made on a regional basis with the same prevailing macroclimate representing relatively stable climatic conditions. Plant communities used in this report consist of the principal plant associations characteristic of the area. Minor variations, in the form of mosaics, are a result of other factors such as differences in soils or topography.

Since man has altered the vegetation through agricultural, grazing, and forestry practices, plant associations which exist at a particular locality may be the natural vegetation, seminatural, or agricultural, depending upon the degree of human disturbance. Therefore, one can describe either the extant (real) or potential natural vegetation. Real vegetation enumerates what is actually there (e.g., wheat field, forest nursery), whereas natural vegetation would be the plant association that would exist if man were removed from the environment and if plant succession were telescoped into a single moment producing stable, self-perpetuating plant communities (each termed the climax or terminal plant community). Time compression eliminates effects of future climatic fluctuations which could possibly create different terminal communities. General classification of potential natural vegetation follows that of Kuchler (1964) or is modified according to Braun (1972) for Tennessee.

III.G.2.a Terrestrial Plant Communities. Braun (1972) classifies most of the Ridge and Valley Province as Oak-Chestnut forest region. However, the oak-chestnut plant association no longer exists because the American chestnut* has been almost completely eliminated by a devastating fungal disease. Yet, its name is still used in the classification schemes. Most frequent dominants include northern red oak, chestnut oak, and yellow poplar or tuliptree. Like other regions, the project area is diversified by inclusions of other plant associations. Present in the Oak Ridge area are scattered elements of the mixed mesophytic forest to the east, hemlock/white pine representing northern forests, and southern pine forests dominated by shortleaf and Virginia pines (Fowells, 1965; Braun, 1972; Oak Ridge Operations, 1975).

In general, the forests of the ridges are oak-chestnut except in sheltered ravines or coves where mixed mesophytic species or beech develop or where hemlock associations occur due to altitudinal variation. Common species found in the mixed mesophytic association are beech, sugar maple, magnolias, buckeye, and basswood (Kitchings and Mann, 1976). Valley floors are dominated by oak with white oak the most characteristic species (Braun, 1972). Yellow poplar often forms nearly pure stands on well-drained bottomlands and lower slopes while willow, sycamore and boxelder border streams and are dominant on poorly-drained floodplains (Kitchings and Mann, 1976).

Kitchings and Mann (1976) determined the dominant plant association of the Oak Ridge Reservation to be Oak-Hickory. It is typified by extensive stands of mixed yellow pine and hardwoods as well as oak and hickory. Plant communities identified are characteristic of those found in the intermountain regions of Appalachia from the Allegheny Mountains in southern Pennsylvania to the southern extension of the Cumberland Mountains in northern Alabama. The Kitchings and Mann (1976) study identified 15

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*Scientific names for plant species are presented in Appendix B.

separate plant communities. However, the vegetation surrounding the Y-12 plant can be described by seven types (Oak Ridge Operations, 1975).

Yellow Pine/Yellow Pine-Hardwoods. Natural forests dominated by shortleaf pine and Virginia pine are associated with large tracts of planted loblolly pine, a valuable timber species. The loblolly pine plantations are monocultures, whereas associated species in the successional forests include oaks, hickories, and tulip poplar.

Hemlock and/or White Pine/Hemlock and/or White Pine with Hardwoods. This type, representing a Southern Appalachian extension of a northern (and higher elevation) forest, is extremely restricted on the reservation. Small areas on Pine Ridge, Black Oak Ridge, Haw Ridge, and north of Melton Hill Dam, all on the western half of the Oak Ridge Reservation, are virtually all that remain. Dominant species are hemlock and white pine.

Cedar and Cedar Pine/Cedar-Hardwoods. This type predominates in Bethel Valley and in southern areas adjacent or close to the Clinch River and Melton Hill Reservoir. Although not uncommon anywhere, the area of this type decreases markedly north of Bear Creek Road. The type is best developed on limestone (or dolomite) and appears rapidly following disturbance. Thus, the present pattern reflects both substrate and the past history (recent) of land use. The dominant species is eastern red cedar associated with shortleaf and Virginia pine, tulip poplar, oaks, hickories, redbud, sassafras, and other hardwoods.

Bottomland Hardwoods. This type, restricted to small floodplains along creek bottoms, is rare on the Oak Ridge Reservation. Small areas occur along Gum Hollow Creek, Bear Creek, and Grassy Creek with larger areas along White Oak Creek and in the reservation portion of the East Fork Poplar Creek drainage. All of the types exist in the western two-thirds of the reservation. Dominant are cottonwood, sycamore, elm, ash, willow, silver maple, and river birch.

Upland Hardwoods. Largest concentrations of this type occur on Black Oak, East Fork, Pine, Chestnut, and Copper ridges. Scattered patches occur almost throughout the reservation area. This forest is esentially an oak-hickory complex, representative of the terminal type in this region of the eastern United States. Important species include chestnut oak, white oak, black oak, northern red oak, scarlet oak, post oak, various hickories and ash, tulip poplar, red maple, black gum, dogwood, and beech. A showy vernal flora is characteristic of this type and many common wildflowers in east Tennessee are virtually restricted to upland hardwood forests.

Northern Hardwoods. Northern hardwood forest is extremely rare on the Oak Ridge Reservation, occurring in small areas only on Black Oak Ridge and on Copper Ridge in the western part of the area. Composition is similar to the Upland Hardwood forest, with admixtures of sugar maple, hemlock, basswood, and buckeye.

Grasslands. The grasslands are of two types. Native or semi-native successional areas are either maintained (e.g., under power-transmission lines) or are reverting to forest. Dominant grasses include species of bluestem, fescue, and bluegrass. Cultivated grasslands are lawns and pastures. These predominate in and around the three plant areas (ORNL, Y-12, and ORDGP) and on CARL lands at the eastern extremity of the reservation. Grasses include fescues, bluegrass, and orchard grass with other species.

The general pattern of succession on abandoned land on the Oak Ridge Reservation and throughout this region of the Southeast is one in which the earliest phase lasts one to several years. It is dominated by annual forbs and grasses such as ragweed and crabgrass. Biennial and perennial forbs such as horseweed, primrose, and many species of composites dominate in the next phase which may last from 4-10 years. The perennial grass phase, usually dominated by broomsedge, follows and may last as long as 20 years in badly eroded areas. Fertility, degree of erosion, light, available moisture, and proximity of seed source appear to be the principal determinants of rates of succession. The perennial grass phase is the most variable in terms of species dominance. Dominants can range from broomsedge to pine seedlings or honeysuckle and brambles. The grass phase is generally followed by a shrub phase as the grassland is invaded by tree seedlings and rapidly growing shrubs and woody vines. Japanese honeysuckle, trumpet creeper, sumac, persimmon, sassafras, red cedar, pines, and various hardwood seedlings are the dominant species for 2-30 years after abandonment of a field (Kitchings and Mann, 1976).

In addition to species native to the area, many plants introduced at the homesites throughout the Reservation have persisted. White poplar and hemlock (which occurs rarely in the area) were often planted in yards. Periwinkle and daffodils mark the locations of virtually all homesites while bridal wreath, rambling roses, and daylilly are also quite common (Kitchings and Mann, 1976).

III.G.2.b Aquatic Vegetation. The aquatic vegetation associated with Bear Creek and the East Fork of Poplar Creek can be described as sparse. Aquatic macrophytes are limited to watercress and cattails. Along these streams, an occasional cover of moss blankets the stream edges. A similar situation exists for the Clinch River in the vicinity of the project area (Exxon Nuclear Company, Inc., 1977).

III.G.2.c Endangered Species. Plants considered rare or threatened for the Oak Ridge Federal Reservation are presented in Table III-24 (Oak Ridge Operations, 1977). Kitchings and Mann (1976) developed a list of plant species in the area worthy of special attention (Table III-25).

III.G.3 Fauna

The Y-12 Plant is located in an area which has fauna typical of both the mature forest and forest-edge habitats in the temperate deciduous forest biome (Kendeigh, 1961). The biota actually observed in the Y-12 area

TABLE III-24. PLANTS OF THE OAK RIDGE RESERVATION THAT ARE RARE, THREATENED OR OF SPECIAL CONCERN[(a)]

Genus Species Authority	Family	Common Name	List	Status	Flower	Seed	Habitat
Cimicifuga rubifolia Kearney	Ranunculaceae	Bugbane	USDI-Fed. Reg.[(b)] USDA-SCS[(e)]	Threatened Threatened	August	August	Rich, sheltered Steep limestone bluff
Delphinium exaltatum Ait.	Ranunculaceae	Tall Larkspur	TCRP[(c)]	Special concern	July-August	October	Dry, calcareous, open woodland
Fothergilla major (Sims) Lodd	Hamamelidaceae	Large Fothergilla	TCRP[(c)] Sharp[(d)] USDA-SCS[(e)]	Threatened Rare Rare	April-May	July-October	Dry woods
Hydrastis canadensis L.	Ranunculaceae	Goldenseal	Sharp[(d)]	Rare	April-May	July	Rich woods
Lilium canadense L.	Liliaceae	Canada Lily	TCRP[(c)]	Threatened	June-July	July-August	Edge of woods
Panax quinquefolius L.	Araliaceae	Ginseng	Sharp[(d)] USDA-SCS[(e)]	Rare Rare	June-July	August-October	Rich, cool, moist woods
Philadelphus sharpianus Hu	Saxifragaceae	Sharp's Mock-Orange	Sharp[(d)]	Rare	May	June-September	Wooded, limestone bluff
Saxifraga careyana Gray	Saxifragaceae	Carey's Saxifrage	USDI-Fed. Reg.[(b)] USDA-SCS[(e)]	Threatened Threatened	April	June	Wooded, limestone bluff
Spiranthes ovalis Lindley	Orchidaceae	Lesser Ladies' Tresses	TCRP[(c)] USDA-SCS[(e)]	Special concern Rare	August-October	November	Moist, shady, rich woods

(a) Source: Oak Ridge Operations, 1977.

(b) Threatened or Endangered Fauna or Flora, Federal Register 40:127 (1975).

(c) Tennessee Committee for Rare Plants, J. L. Collins (TVA), H. R. DeSelm (UT), A. M. Evans (UT), R. Kral (Vanderbilt), and B. E. Wofford (UT), September 1976.

(d) Sharp, A. J. Tennessee Conservationist, July 1974.

(e) "Rare, Threatened or Endangered Plant Species of Tennessee", U.S. Department of Agriculture, Soil Conservation Service, May 1975.

TABLE III-25. PLANT SPECIES OF SPECIAL INTEREST OR OF LIMITED DISTRIBUTION WITHIN THE OAK RIDGE RESERVATION[a]

Species	Habitat	Status: Reservation		Status: State	
		Uncommon	Rare	Locally Abundant	Rare
Arisaema dracontium (Green dragon)	Near ponds at Gaseous Diffusion Plant (K-25)		X	X	
Chionanthus virginicus (Old-Man's-beard)	Bluffs over Melton Hill Lake (CRM 26)		X	X	
Dicentra cucullaria (Dutchman's breeches)	Copper Ridge near Melton Hill Lake (CRM 25-26)		X	X	
Epigea repens (Trailing arbutus)	Chestnut Ridge near New Zion Cemetery		X	X	
Erythronium americanum (Dog's-Tooth violet)	Bottomlands along East Fork Poplar Creek		X	X	
Jeffersonia diphylla (Twinleaf)	Bluffs downstream from Melton Hill Dam (CRM 22.5)		X	X	
Lithospermum canescens (Puccoon)	Rocky Site near Clinch River (CRM 17.5)	X		X	
Magnolia tripetala (Greatleaf magnolia)	Haw Ridge at White Oak Creek and Walker Branch		X	X	
Orchis spectabilis (Showy orchid)	Copper Ridge adjacent to the Cesium Forest Area		X	X	

TABLE III-25. (Continued)

Species	Habitat	Status: Reservation Uncommon	Status: Reservation Rare	Status: State Locally Abundant	Status: State Rare
Ornithogalum umbellatum (Star-of-Bethlehem)	Copper Ridge adjacent to the Cesium Forest Area		X	X	
Philadelphus hirsutus (Mock-orange)	Bluff above Melton Hill Lake		X	X	
Poncirus trifoliata (Trifoliate orange)	Home site near Haw Ridge and White Oak Circle		X	X	
Sanguinaria canadensis (Bloodroot)	Bluffs above Melton Hill Lake (CRM 25.5)		X	X	
Staphylea trifolia (Bladdernut)	Streams near Melton Hill Lake and Walker Branch		X	X	
Tilia americana (Basswood)	East end of Pine Ridge near Bear Creek		X	X	
Waldsteinia fragarioides (Barren strawberry)	Woods near Experimental Gas-Cooled Reactor Site		X	X	
Wisteria sinensis (Chinese wisteria)	Abandoned homesite		X	X	

(a) Source: Kitchings and Mann, 1976.

have been reported in several documents. For example, the aquatic and terrestrial biota present on a 1,012-ha (2,500-acre) site only 9.7 km (6 mi) southwest of Y-12 have been surveyed in detail (Exxon Nuclear Company, Inc., 1977). This area includes wildlife habitats similar to those surrounding Y-12. Terrestrial biota of the Oak Ridge area have been summarized by Kitchings and Mann (1976). A preliminary survey of aquatic biota in the two streams receiving effluent water from Y-12 was made by Alexander (1979).

III.G.3.a Terrestrial Fauna. The mammals, birds, and herpetofauna identified during several different intensive surveys and those species which are expected to occur on the Oak Ridge Reservation include an impressive variety of species. These species and their preferred habitat types have been listed (including all scientific names) by Kitchings and Mann (1976). Some of the species, such as small mammals and herpetofauana, may restrict their movements to a single habitat type. Large mammals and birds, however, may range over several habitats. The six habitat types on the Oak Ridge Reservation include three hardwood forest habitat types (oak-hickory, chestnut-oak, and flood plain forest), pine plantations, old field, and wetlands.

Mammals. The mammals found in the area of the Y-12 Plant are generally southern in geographic affinity, although most of them have widespread distribution in North America (Exxon Nuclear Company, Inc., 1977). Of more than 70 mammalian species presently occurring in Tennessee, about 50 have geographic ranges which include the site.

Mammals common to the three hardwood forest habitat types include species found in many other habitats. Predatory mammals ranging through all habitats include the red and gray fox*, bobcat, and long-tailed weasel. White-tailed deer and opossum are also common residents in most of the habitat types. Small mammals which are particularly abundant in the upland forest habitats are the white-footed mouse, eastern chipmunk, and golden mouse (Howell and Dunaway, 1959; Kitchings and Mann, 1976).

Mammals which are relatively common in pine plantations include the southeastern shrew, southern short-tailed shrew, white-footed mouse, and golden mouse. Larger mammals, such as the gray squirrel, opossum, white-tailed deer and predatory mammals mentioned previously, also utilize this habitat type to some extent (Kitchings and Mann, 1976; Exxon Nuclear Company, Inc., 1977).

Small mammals are particularly abundant in the old field habitat (Kitchings and Mann, 1976). Species common to this habitat are the cotton rat, white-footed mouse, golden mouse, rice rat, and short-tailed shrew. The eastern cottontail is probably more common in this habitat type than any of the other habitats in the area. Large mammals, such as the predatory fox, bobcat and weasel, may, at times, hunt in this habitat type. White-tailed deer and opossum regularly forage in old field habitats.

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*Scientific names for animal species are presented in Appendix B.

Avifauna. Nearly 300 species of birds, exclusive of accidentals and casual visitors, occur within the Tennessee state borders (Exxon Nuclear Company, Inc., 1977). A description of the avifauna for Knox County, which is adjacent to the Oak Ridge Reservation, indicate that about 251 bird species have been recorded in that county. However, the habitats around the Y-12 Plant are primarily mature forest and lack large areas of grassland and wetlands, resulting in an avifauna that is less diverse than that described for Knox County.

Over half of the avifauna frequenting the area are seasonal in occurrence. For example, surveys at a site 9.7 km (6 mi) southwest of Y-12 indicated that, of the 96 total bird species identified during all seasons, 45 were permanent residents, 6 species were winter residents only, 38 species were summer residents only, and 6 species were believed to be present only during migration (Exxon Nuclear Company, Inc., 1977). The breeding season, during late spring and early summer, is a time when the species composition stabilizes and breeding pairs set up territories associated with specific habitats. Thus, the following discussion of birds common tc various habitats is relevant primarily to the breeding season.

Birds typically found in the hardwood forest habitat include: red-eyed vireo, yellow-shafted flicker, red-bellied woodpecker, downy and hairy woodpeckers, common crow, bluejay, Kentucky warbler, pine warbler, ovenbird, yellow-breasted chat, Carolina chickadee, tufted titmouse, scarlet tanager, and summer tanager. Raptors which nest and hunt in the woodlands include the red-shouldered and broad-winged hawk. Several species of owls also utilize this habitat type for nesting (Howell, 1958; Kitchings and Mann, 1976).

Bird species have a low preference for pine plantations (Kitchings and Mann, 1976). Pine warblers and white-throated sparrows are most numerous in this habitat.

Bird species utilize the old field areas heavily during the breeding season. This habitat is used by sparrows, rufous-sided towhees, bobwhite, and mourning dove. Raptorial species utilize the old field areas for hunting (Kitchings and Mann, 1976).

Herpetofauna. Herpetofauna (reptiles and amphibians) have been studied intensively on the Oak Ridge Reservation by Johnson (1964). Examples of species associated with the hardwood forest habitat include the American and Fowler's toads, red-backed salamander, eastern box turtle, northern copperhead, timber rattlesnake, black rat snake, and five-lined skink. On the other hand, the pine plantations are nearly devoid of herpetofauna. The old field areas provide habitat suitable for most of the frogs, toads, lizards, and snakes reported by Johnson (1964). Examples of herpetofauna associated with the old fields include the American and Fowler's toads, eastern box turtle, six-line racerunner, black rat snake, five-lined skink, northern black racer, fence lizard, northern brown snake, eastern garter snake, and eastern hognose snake. Most of the turtles and amphibians are associated with wetland habitat either as their permanent niche or as a temporary breeding or overwintering site. Examples of species commonly associated with the wetlands include: map turtle, slider, yellow-bellied turtle, snapping turtle, dusky salamander, northern red salamander, hellbender, red-spotted newt, mudpuppy, and northern watersnake.

III.G.3.b Aquatic Fauna. Both Bear Creek and East Fork Poplar Creek have been sampled for aquatic fauna. This effort represented a preliminary aquatic survey. A more detailed study has been conducted on Bear Creek (Exxon Nuclear Company, Inc., 1977). Both creeks are slow moving streams with a minimum of scouring. Headwaters of both tributaries are closely associated with Y-12 Plant activities. Bear Creek receives disposal pond seepage at its origin; the stream is dry for a portion of its length during the summer when rainfall is low. Effluent from the New Hope Pond represents the origin of East Fork Poplar Creek. Because of daily discharge from the pond, the creek is not intermittent (McMaster, 1967).

Bear Creek has a clay-rock substratum dominated by gravel (Exxon Nuclear Company, Inc., 1977; Alexander, 1979). Diatoms dominate the phytoplankton (Bacillariophycae) and periphyton (Chrysophyta). Arthropods dominate the benthic community (Exxon Nuclear Company, Inc., 1977). Representative invertebrates collected include crayfish, mayflies, caddisflies, damselflies, water pennies, and cranefly, plus mosquito larvae (Alexander, 1979). Presence of mosquito larvae and some species of caddis flies are indicative of low flow streams (Cairns and Dickson, 1971). The dominant gamefish is rock bass (Exxon Nuclear Company, Inc., 1977). It is most abundant where stream bottoms consist of boulders or gravel and an adequate supply of crayfish and insect larvae exist (Clay, 1962). The most abundant forage fish is the common shiner and the white sucker dominates the rough fish (Exxon Nuclear Company, Inc., 1977). Both species have habitat requirements similar to rock bass (Trautman, 1957).

East Fork Poplar Creek is primarily a sediment-rich stream. The bottom sediments are basically silt with considerable mud accumulation. Reported aquatic fauna included tubifex, crayfish, burrowing mayflies, damselflies, plus the larvae of cranefly, mosquito, and midge. These are representative of high siltative loads (Cairns and Dickinson, 1971). Alexander (1979) noted the presence of minnows in the headwater but species identification was not provided. Based on species absence/presence, it is concluded that East Fork Poplar Creek has poorer water quality than Bear Creek. This observation is based on the lack of tubifex and the presence of Trichoptera in Bear Creek plus the presence of Chironomus only in East Fork Poplar Creek.

III.G.3.c Endangered Species. Five species of terrestrial fauna considered endangered by the U.S. Department of the Interior (1978) have been observed on or around the Oak Ridge Reservation. The only two federally endangered mammalian species likely to occur on the reservation are the Indiana myotis (*Myotis sodalis*) and the gray myotis (*Myotis grisescens*) (Howell and Dunaway, 1959). The Indiana bat inhabits caves and hollow trees and thus may occur on the area. Many of these bats have been reported from New Mammoth Cave in Campbell County, 88.5 km (55 mi) from Oak Ridge (Kitchings and Mann, 1976). Neither the Indiana or gray bat has been reported on the Oak Ridge Reservation (Project Management Corporation, et al., 1977). Three federally endangered birds have been reported on the reservation or in its general vicinity. The southern bald eagle (Haliaeetus l. leucocephalus) has been observed along the Clinch River. A nesting site has been located on Watts Bar Reservoir off the reservation, but the reservation appears to be within the established range of this species (Oak Ridge Operations, 1978). The peregrine falcon (Falco peregrinus (subspecies not indicated) has been reported from Knox County (Exxon Nuclear Company, Inc., 1977) and is considered a fall, winter, and spring visitor to the Tennessee Valley (Welborn, 1974) but has not been reported on the reservation. The red-cockaded woodpecker (Picoides borealis) is known to occur in Cumberland County, about 80 km (50 mi) from Y-12 (Exxon Nuclear Company, Inc., 1974). This woodpecker requires mature pines infected with red-heart disease for nest cavity construction. No nests, however, have been reported on the reservation. Also, the eastern cougar (Felis concolor) has been sighted on the Oak Ridge Federal Reservation numerous times and the reservation should be considered part of this species' range (Oak Ridge Operations, 1977).

Thirteen species of terrestrial fauna known or expected to occur in the area of the Oak Ridge Reservation are classified as endangered or threatened by the State of Tennessee (Tennessee Wildlife Resources Commission, 1978). The Tennessee cave salamander (Gyrinophilus palleucus), reported from Roane County, is considered threatened (Exxon Nuclear Company, Inc., 1977). The Bachman's (pinewoods) sparrow (Aimophila aestivalis) has been observed on the reservation and is considered endangered. The sharp-shinned hawk (Accipiter striatus) has been observed on the reservation and is considered threatened.

One bird species considered endangered in Tennessee, the osprey (Pandion haliaetus), and four bird species considered threatened in Tennessee, the Cooper's hawk (Accipiter cooperi), the marsh hawk (Circus cyaneus), the Bewick's wren (Thyromanes bewickii), and the grasshopper sparrow (Ammodramus savannarum), are expected to occur on the Oak Ridge Reservation surrounding Y-12 (Kitchings and Mann, 1976).

In addition, all five of the federally endangered species listed in the previous paragraph are also considered endangered by Tennessee. None of the aquatic species on the Tennessee state endangered or threatened species list were encountered during the Exxon study (1977) of Bear Creek.

III.G.4 Sensitive Areas

No national wildlife refuges, parks, or forests are maintained by the Federal government in the vicinity of Oak Ridge. The Great Smoky National Park is south-southeast of Knoxville some 64 km (40 mi) from Oak Ridge. Adjacent to the park is Cherokee National Forest. It is situated along the Tennessee-North Caroline states' border and is no closer than 96 km (60 mi) from the project area.

The U.S. Fish and Wildlife Service (Appendix C) has no designated national wetlands in eastern Tennessee. In their recent study of inland wetlands of the United States, Goodwin and Niering (1975) did not identify any wetlands in Anderson or Roane counties. Kitchings and Mann (1976) noted several swampy areas within the Oak Ridge Federal Reservation. However, none are extensive with the largest tract about .2 ha (.5 acre) in size.

Several natural areas are found in the Reservation and are of scientific value. They are important because of species composition or stage of ecological development. Although 25 areas have been identified, none are located immediately adjacent to Y-12 (Oak Ridge Operations, 1975; Kitchings and Mann, 1976).

III.H CULTURAL, ARCHAEOLOGICAL, AND HISTORICAL CONSIDERATION

III.H.1 Cultural and Archaeological

The eastern section of Tennessee has seen a long sequence of human occupation; all of the major stages in the cultural evolution of the American Indian have been reported in the archaeological literature. When the first Europeans came into this section of East Tennessee, the Indians they encountered were the Cherokee, the last in a series of aboriginal inhabitants who had occupied the area for at least 10,000 years. Their predecessors do not have tribal names such as Cherokee, but are known by their archaeological culture names (Fielder, 1974).

The first known period of human occupation in the East Tennessee region is the Paleo-Indian. Current estimates place the initial known occupation about 10,000 years ago. There is not a settlement pattern as such characteristic of this period since the population consisted of nomadic hunters. The presumed subsistence base was principally large-game hunting supplemented by gathering edible plants and plant parts (Fielder, 1974).

The Archaic period lasted from the end of the Paleo-Indian period to the beginning of the Woodland period, roughly from about 6000 years ago to about the beginning of the Christian era. The settlement pattern appears to be a riverine distribution. Most of the known sites in East Tennessee are located on river or stream terraces. The subsistence base, similar to the one in the Paleo-Indian period, put less emphasis on large-game animals and more on the collection of aquatic resources along with the procurement of edible plant foods (Fielder, 1974).

The Woodland period lasted from about the beginning of the Christian era (1000 B.C.) to ca. 1000 years A.D. A seasonal settlement pattern evolved correlated to the area of resource availability. A model subsistence—settlement pattern is summer-fall settlements along the rivers to exploit shellfish and other aquatic animals, and winter-spring where smaller groups participated in hunting forays from their upland rockshelters. Late in this period the disposal of the dead in mounds became a typical trait (Fielder, 1974).

The Mississippian period is the time of extensive agricultural product-based aboriginal societies in eastern Tennessee. The period began around 1000 years A.D. and it lasted until the incursion of Europeans in the late 17th century. The Mississippian period is characterized by large settled villages stabilized by the production of corn or maize. The size and permanence of the Mississippian villages indicate a year-round occupation, although there were probably small seasonal hunting-and-gathering camps used in addition to the main village. The villages were located on the lower terraces where the soil was more suitable for agricultural purposes (Fielder, 1974). The Mississippian period ended with the advent of European explorers into the East Tennessee area, thus bringing in the Historic period. Only in the Historic period can tribal affiliations be determined. They are based on a multitude of cultural factors. The ethnographic tribe living in the Oak Ridge area was the Overhill Cherokee. Their center of population was in the Little Tennessee River Valley in present-day Monroe County, but their activities extended into the Oak Ridge area (Fielder, 1974).

Archaeological surveys have yielded findings from each period within the Oak Ridge Federal Reservation except for the Historic Native American (Fielder, 1974). Known archaeological sites are presented in Figure III-18.

III.H.2 Historical

The first Euroamericans in the Oak Ridge area came in when the Cherokees were still in possession. These early whites included the French and English. The English established Fort Loudoun on the Tellico River in 1756 to thwart the French incursion into East Tennessee and provide a foothold for English settlement there. The area was first settled in the late 1700's. The first settlers in what is now the Oak Ridge Federal Reservation were William Tunnell, Anne Howard, Isaac Freels, and Collins Roberts. The descendants of these families were still in the area when the Corps of Engineers acquired the land for the Manhattan Project in 1942. By this time approximately 3000 persons (1000 families) were living in the immediate area affected by the project (Fielder et al., 1977).

The National Register of Historic Places (Federal Register, 1979) was consulted and eight listings appear for Anderson and Roane Counties. Only one property occurs in Oak Ridge and the remaining seven are located in surrounding communities. The X-10 Graphite Reactor has become a national historic monument. It is located in the Oak Ridge National Laboratory approximately 8 km (5 mi) from the Y-12 Plant.

A study performed by Fielder et al. (1977) on the Oak Ridge Federal Reservation assessed the historical significance of extant buildings and structures that predated Federal acquisition. Of the 115 foundation remains, nine occur in Bear Creek Valley, and only one standing structure exists compared to 41 on the entire Reservation. One structure, a double-pen log house known as Freels Cabin, is an excellent example of early nineteenth century log architecture. It was considered worthy of inclusion in the National Register (Fielder et al., 1977). However,

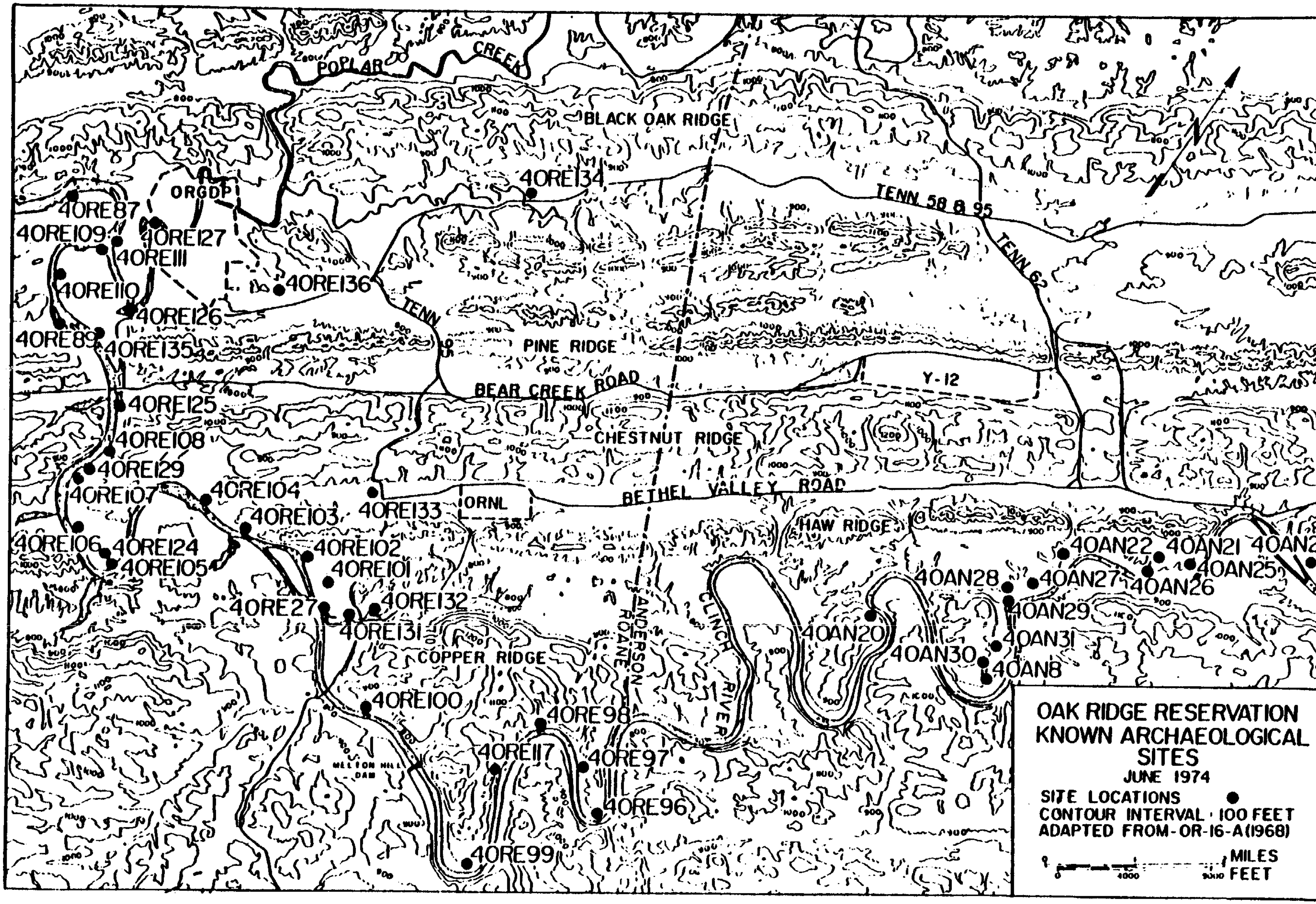


FIGURE III-18. KNOWN ARCHAEOLOGICAL SITES IN THE OAK RIDGE AREA

Source: Fielder, 1974.

this structure is over 3.2 km (2 mi) from the Y-12 Plant and is separated from it by Chestnut and Haw Ridges.

III.I.1 Safeguards and Security

The mission of the Y-12 Plant necessitates stringent safeguards and security requirements, and, as a result, there is extensive activity in this area which compliments the environmental protection program. The fact that the facility is a high security area assures that responsible personnel are always physically present at the site in the event of any incident. Security inspectors make regular rounds and would observe any incidents involving releases of chemicals and would be aware of any explosions or fires which might have on-site or off-site environmental impacts. Regular rounds are also made by process operators both inside and outside buildings. The activities of the security inspectors and the process operators are supported by full-time security and emergency staffs which provide immediate aid in the event of potential environmental impacting incidents. The response of these support groups is directed by a staff of full-time superintendents.

Because the plant is a security area, the site is fenced, and the public is excluded. This exclusion limits the possibility of accidental or malicious incidents due to public interactions with the environmentally significant materials present on the plant site.

In summary, the presence of the security restrictions at the Y-12 Plant reduces the probability of environmentally significant incidents and enhances the ability to detect and investigate incidents which may occur.

III.I LITERATURE CITED

Alexander, J. K. 1979. Background environmental information--Y-12 Plant. Report No. ORO-771. U.S. Department of Energy, Oak Ridge, TN.

Bailey, R.G. 1976. Ecoregions of the United States. USDA Forest Service, Odgen, UT (map).

Bailey, R. G. 1978. Description of the ecoregions of the United States. USDA Forest Service, Odgen, UT (pamphlet).

Bolt, B. A. 1978. Earthquakes, a primer. W. H. Freeman and Co., San Francisco, Calif.

Braun, E. L. 1972. Deciduous forests of eastern North America. Hafner Pobl. Co., NY.

Cairns, J., Jr. and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharges on aquatic bottom dwelling organisms. J. Water Poll. Control Fed. 43:755-772.

Canter, L. W. 1977. Environmental impact assessment. McGraw-Hill Book Co., New York.

Carroll, D. 1961. Soils and rocks of the Oak Ridge area, Tennessee. Trace elements investigations report 785, U.S. Geological Survey, Washington, D.C.

Clay, W. M. 1962. A field manual of Kentucky fishes. Kentucky Dept. Fish Wildlife Resour., Frankfort, KY.

Dickson, R. R. 1974. The climate of Tennessee. In: Climates of the states. Vol. 1. Water Inform. Center, Inc., Nat. Oceanic Atmos. Admin., Port Washington, N. Y., p. 370-384.

Dolar, S. G., D. R. Kenney, and G. Chesters. 1971. Mercury accumulation by *Myriophyllum spicatum* L. Environ. Letters. 1:191-198.

East Tennessee Development District. 1979. Land use plan, 1979-2000. Knoxville, TN.

Exxon Nuclear Company, Inc. 1977. Nuclear fuel recovery and recycling: Environmental REport, Vol. I. XN-FR-33.

Federal Register. 1978a. Code of Federal Regulations, Title 40; Part 81: Air quality control regions, criteria, and control techniques. Vol. 43:8962-9059.

Federal Register. 1978b. Code of Federal Regulations, Title 40; Part 81: Air quality control regions, criteria, and control techniques. Vol. 43:40412-40448.

Federal Register. 1979. National Register of Historic Places: Annual listing. Dept. Interior. Vol. 44:7415-7649.

Fielder, G. F., Jr. 1974. Archaeological survey with emphasis on prehistoric sites of the Oak Ridge Reservation, Oak Ridge, Tennessee. Report No. ORNL-TM-4694. Oak Ridge Nat. Lab., Oak Ridge, TN.

Fielder, G. F., Jr., S. R. Ahler, and B. Barrington. 1977. Historic site reconnaissance of the Oak Ridge Reservation, Oak Ridge, Tennessee. Report No. ORNL-TM-5811. Oak Ridge Nat. Lab., Oak Ridge, TN.

Fowells, H. A. 1965. Selvics of forest trees of the United States. Agric. Handbook No. 271. USDA Forest Service, Washington, D.C.

Goodwin, R. H. and W. A. Niering. 1975. Inland wetlands of the United States. National Hist. Theme Stud. No. 2, U.S. Nat. Park Service, Washington, D.C.

Hammond, P. B., I. C. T. Nisbet, A. F. Sarofim, W. H. Drury, and N. Nelson. 1972. PCBs--environmental impact. Environ. Res. 5:249-362.

Hilsmeier, W. F. 1963. Supplementary meteorological data for Oak Ridge, Tennessee. U.S. Weather Bur. Res. Station, Oak Ridge, TN.

Howell, J. C. 1958. Long-range ecological study of the Oak Ridge area. I. Observations on summer birds in Melton Valley. Cent. File No. 58-6-14. Oak Ridge Nat. Lab., Oak Ridge, TN.

Howell, J. C. and P. B. Dunaway. 1959. Long-range ecological study of the Oak Ridge area. II. Observations on the mammals with special reference to Melton Valley. ORNL/CF/59-10-126. Oak Ridge Nat. Lab., Oak Ridge, TN.

Hunt, C. B. 1974. Natural regions of the United States and Canada. W. H. Freeman & Co., San Francisco, CA.

Johnson, R. M. 1964. Herpetofauna of the Oak Ridge area. ORNL-3663. Oak Ridge Nat. Lab., Oak Ridge, TN.

Kendeigh, S. C. 1961. Animal ecology. Prentice-Hall, Inc. Englewood, N.J.

Kitchings, T. and L. K. Mann. 1976. A description of th terrestrial ecology of the Oak Ridge Environmental Research Park. Report No. ORNL-TM-5073. Oak Ridge Nat. Lab., Oak Ridge, TN.

Kuchler, A. W. 1964. Manual to accompany the map: Potential natural vegetation of the conterminous United States. Amer. Geogr. Soc. Publ. No. 36.

Ljunggren, K., B. Sjostrand, A. G. Jolinels, M. Olsson, G. Otterlind, and T. Westmark. 1971. Activation analysis of mercury and other environmental pollutants in water and aquatic ecosystems. In: Nuclear Techniques in Environmental Pollution, International Atomic Agency, Vienna, Austria.

McMaster, W. M. 1964. Geologic map of the Oak Ridge Reservation, Tennessee. Report No. ORNL-TM-713. Oak Ridge. Nat. Lab., Oak Ridge, TN.

McMaster, W. M. 1967. Hydrologic data for the Oak Ridge area, Tennessee. Water-Supply Paper 1839-N. U.S. Geological Service, Washington, D.C.

Oak Ridge Operations. 1975. Oak Ridge land-use plan. Report No. ORO-748. U.S. Energy Research and Development Administration, Tech. Info. Center, Oak Ridge, TN.

Oak Ridge Operations. 1977. Supplement-Oak Ridge land-use plan. U.S. Department of Energy, Oak Ridge, TN.

Oak Ridge Planning Department. 1978. Oak Ridge land-use plan. Oak Ridge, TN.

Oosting, H. J. 1956. The study of plant communities. 2nd ed. W. H. Freeman & Co., San Francisco, CA.

Project Management Corporation. 1977. Clinch River Breeder Reactor Plant; Environmental Report.

Sales Management, Inc. 1978. Survey of buying power, data service. Sales and Marketing Mgmt. Magazine.

Shelford, V. E. 1974. The ecology of North America. Univer. Ill. Press., Urbana, IL.

Swain, M. E. 1942. Soil survey Roane County, Tennessee. U.S. Department of Agriculture, Washington, D.C.

Tennessee State Department of Economic and Community Development, Division of Industrial Development. 1979. Tennessee Community Data. Nashville, TN.

Tennessee Wildlife Resources Commission. 1978. TWRC proclamation: endangered or threatened species. Proc. No. 75-15 as amended by Proc. No. 77-4 and 78-14. Tenn. Wildl. Res. Comm., Nashville, TN (mimeo).

Trewartha, G. T. 1968. An introduction to climate. McGraw Hill Book Co., NY.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press. Columbus, OH.

Union Carbide. 1979. Environmental monitoring report United States Department of Energy, Oak Ridge facilities, calendar year, 1978. Report No. Y-UB-10. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

U.S. Department of Agriculture, Soil Conservation Service. 1974. General soil map of Tennessee. Nashville, TN (map).

U.S. Department of Agriculture, Soil Conservation Service. 1979. Prime and unique farmland soils in Anderson County, Tenn. Oak Ridge, TN (letter).

U.S. Department of Commerce. Bureau of Census. 1979. Community Patterns, 1977. Washington, D.C.

U.S. Department of Commerce Environmental Science Services Administration. 1969. Severe storm occurrences, 1955-1967. Tech. Memo. WBTM FCST 12. Silver Springs, MD.

U.S. Department of Commerce, National Climatic Center. 1978. Local climatological data, annual summary, Oak Ridge, Tennessee. Asheville, NC.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1973. Thunderstorms. Publ. NOAA/PA 70014. Washington, D.C.

U.S. Department of Interior, Heritage Conservation and Recreation Service. 1979. National wild and scenic rivers system. Washington, D.C. (map).

U.S. Department of Interior. 1978. List of endangered and threatened wildlife and plants. Fed. Reg. 43:58030-58048.

Weaver, J. E. and F. E. Clements. 1929. Plant ecology. McGraw-Hill Book Co., NY.

Welborn, T. C. 1974. A checklist of birds of the Tennessee Valley. TVA, Div. For., Fish, Wildlife Develop., Norris, TN.

IV
ENVIRONMENTAL CONSEQUENCES

IV.A PROPOSED ACTION

IV.A.1 Potential Impacts

IV.A.1.a Land Use. Oak Ridge is a projected major urban-industrial growth center (Figure IV-1) during the last part of this century (East Tennessee Development District, 1979). According to the Oak Ridge City land use plan (1978), the city will grow through the 1980's and then level off. This growth can be accommodated by available vacant lands suitable for residential development. Also, a large portion of the Oak Ridge work force will continue to live outside the city.

Since no Y-12 expansions are projected (Oak Ridge Operations, 1975, 1978), land use patterns on the federal reservation will remain unchanged by the proposed action. Consequently, no impact on land use is anticipated other than the restrictive nature of the reservation itself on the City of Oak Ridge. This lack of development by the city onto the reservation will continue regardless of the Y-12 operation.

IV.A.1.b Socioeconomic Impacts. The scenario for the proposed action is simply "business as usual". This would mean that normal activities at the Y-12 Plant would continue at current levels of employments. Hence, the economic viability of the City of Oak Ridge and the counties of Anderson and Roane will continue to depend upon the employment and income generated from the operations of the Y-12 Plant.

As presented in Table IV-1, the Y-12 Plant employed 6,166 persons as of December 1978 and paid out $109.4 million in payroll. Approximately 57 percent of these employees reside within the two counties of Anderson and Roane and account for 59 percent of the annual payroll. The City of Oak Ridge alone received a payroll of over $35 million for the 29 percent of the plant employees who resided in the city.

TABLE IV-1. EMPLOYMENT AND ANNUAL PAYROLL DISTRIBUTION OF THE Y-12 PLANT, DECEMBER 1978

Communities	Employment	Payroll
Oak Ridge	1,779	35,028,146
Anderson (outside of Oak Ridge)	909	15,600,972
Roane (outside of Oak Ridge)	830	13,507,545
Others	2,648	45,228,185
TOTAL	6,166	109,364,848

Source: Union Carbide, 1979a.

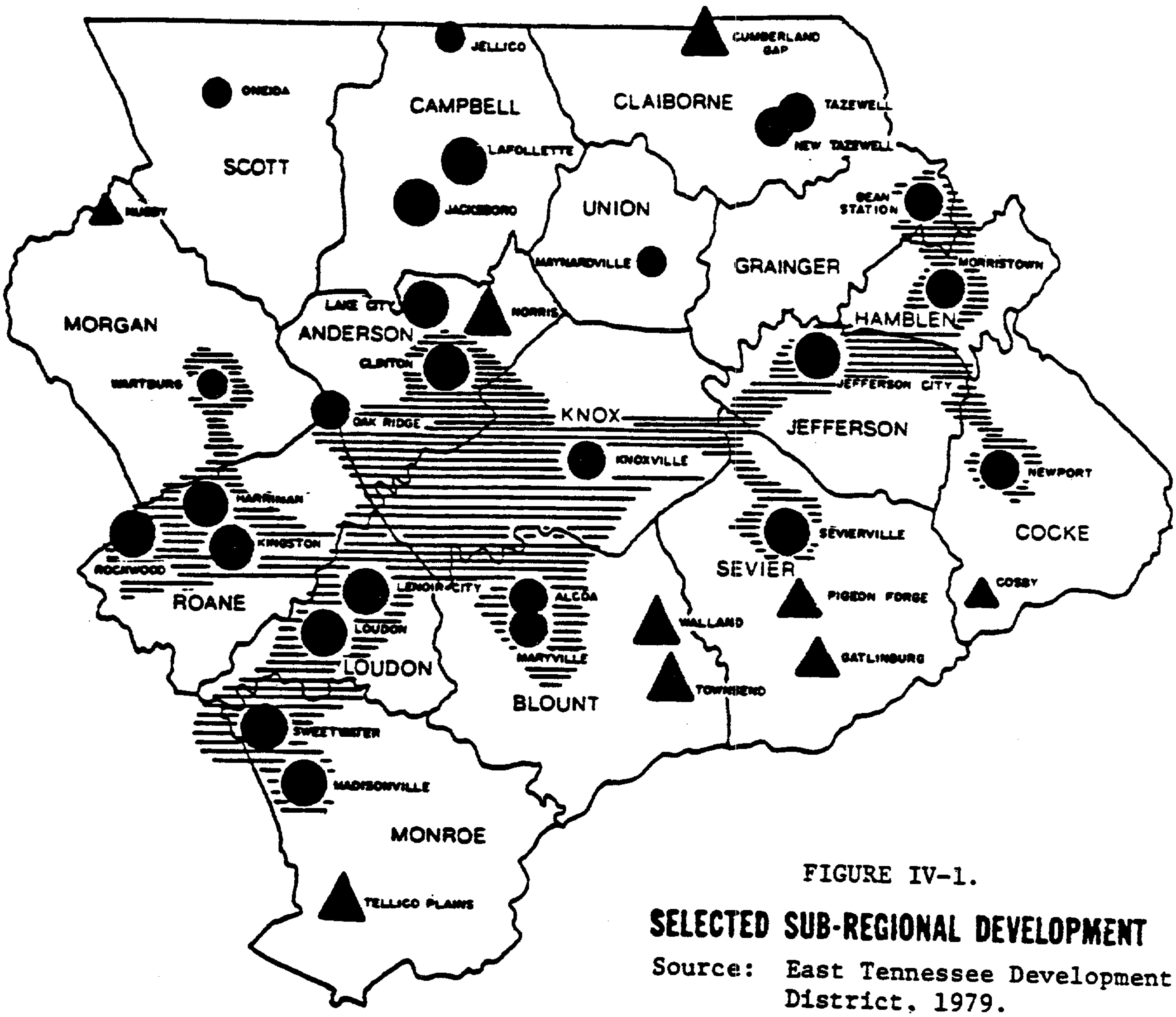


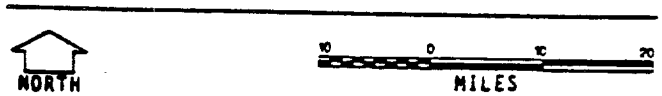
FIGURE IV-1.

SELECTED SUB-REGIONAL DEVELOPMENT

Source: East Tennessee Development District, 1979.

LEGEND

- ● URBAN-INDUSTRIAL GROWTH AREAS
- ▲ RECREATIONAL GROWTH AREAS
- ≡ POTENTIAL URBANIZED CORRIDORS



The Y-12 Plant at Oak Ridge plays a significant role in the socioeconomic activities of the City of Oak Ridge as well as neighboring communities. It is not only the direct effects of employment and earnings that need to be examined but also the indirect effects through the multipliers that make themselves felt on other industries, such as sales, services, retail and wholesale trades, as well as financial institutions.

Should there be a major change in policy and the activities of the Y-12 Plant are altered from that of the status quo, it is important to note that the socioeconomic activity of the communities under consideration will be greatly affected. The direction and magnitude of change or impact are dependent upon the scenario for the proposed future action.

IV.A.1.c Geological Impacts. No changes to the integrity of the geological substratum have been detected during the operation of Y-12. Consequently, no impacts are anticipated from continued operations. Seismically, the area is stable and damage from earthquakes is considered negligible.

Since no expansion is projected, no prime/unique farmland soils will be impacted.

Stream sediments are of concern because of toxic substance contamination. These sediments may be removed for decontamination or left *in situ*. Because known concentrations of PCB and mercury are below the recommended standards for deposit removal (total mercury, 25 mg/kg; PCB, 10 mg/kg; Murakami and Takeishi, 1977), it seems that these stream sediments may be left intact without hazard to the surrounding environs.

IV.A.1.d Hydrological Impacts. The quality of the water in Bear Creek and East Fork Poplar Creek from Y-12 operations should improve in coming years due to projects which are in progress or which are proposed. The line-item project, Control of Effluents and Pollutants, Y-12 (81-D-120) provides for the neutralization, precipitation, settling, and filtration of aqueous waste streams generated in the Y-12 Plant in the course of normal operations.

This project will improve water quality in the creeks although the discharges to these creeks currently meet NPDES permit levels.

A second project has been proposed to further improve the water quality of the two creeks. The project would provide a system for treating the runoff from the coal pile and some other aqueous streams. Also included in this project are systems to handle various sludges generated while treating aqueous streams, the disposal of hazardous materials, and purification of contaminated oils.

The City of Oak Ridge is also in the process of constructing a new sewage treatment plant on East Fork Poplar Creek downstream from Y-12. When this plant is completed, water quality downstream of the sewage treatment plant will be significantly improved.

IV.A.1.e Meteorological and Air Quality Impacts. Operation of the Y-12 Plant will not change the climate of Oak Ridge nor the region. Possibly the most serious consequences from an accident would be the release of bulk chemicals to the local waterways as a result of a tornado. The storage facilities are protected by existing containment dikes (Sanders, 1977). However, the probability of such a severe storm is remote.

The air quality impacts from Y-12 operations will be improved by the project, Steam Plant Improvements - Y-12 (78-17-D) by the installation of baghouses on the Y-12 Steam Plant. This facility will reduce particulate emissions to levels which are in compliance with existing air quality regulations.

A project is also proposed to install scrubbers to remove hydrogen fluoride from vent streams to assure compliance with ambient standards for fluoride emissions.

IV. A.1.f Biological Impacts. Destruction of existing vegetation is not expected because there are no planned plant expansions at present. Data on the uranium and fluoride content in vegetation have been collected through the environmental monitoring program (Union Carbide, 1979b). Fluoride concentration in grass was below the 30 ppm level considered to produce no adverse effects when ingested by cattle (Anon., 1969; Union Carbide, 1979b). Likewise, uranium concentrations were below levels of environmental concern (Union Carbide, 1979b). Since Y-12 has switched its coal source to low sulfur coal, sulfur dioxide releases into the atmosphere now conform to existing standards. However, unless particulate emissions are reduced, the surrounding vegetation will suffer negative impacts though perhaps difficult to measure, if at all. Theoretically, particulates could decrease the rate of photosynthesis due to foliar deposition; and as a consequence, the plants could experience reduced growth. However, no studies to date verify this phenomena (Lerman and Darley, 1975). No threatened or rare plants, known or potential, will be impacted; no expansion is planned at Y-12.

Fauna may experience some negative impact through vehicular-related deaths. However, the number of deaths will be small. The effects of toxic substances related to Y-12 operations are a more important concern. Since Bear Creek and East Fork Poplar Creek have received accidental discharges of mercury and PCB, bioconcentration of these compounds by aquatic organisms will continue to be evaluated. Fish analysis for mercury reveal flesh samples are close to the 0.5 μg/g guideline. These 1978 concentration data are generally lower than previously observed. Likewise, PCB values in fish flesh show little bioconcentration of the compound. The majority of samples contained <0.1 μg/g of PCB (Alexander, 1979).

Although threatened and endangered animal species are present at the DOE reservation, these should not be impacted because there will be no habitat destruction due to continued Y-12 operations.

IV.A.1.g <u>Historical and Archaeological Impacts</u>. No historic properties will be affected by the proposed action. No archaeological sites have been identified on the Y-12 property.

IV.A.2 Unavoidable Adverse Environmental Effects

IV.A.2.a <u>Abiotic Effects</u>. The Oak Ridge Federal Reservation consists of about 37,000 acres, restricting this land for other productive uses. About 5,000 acres are presently preempted—about 1,800 acres are within the perimeter fences of ORGDP, ORNL, and the Y-12 Plant; about 2,400 acres are used for power transmission corridors; about 140, underground pipelines; about 70 acres, railroads; about 500 acres, security fences. There are about 270 acres reserved for burial grounds at the three facilities and this land is eliminated for most other uses for many years.

IV.A.2.b <u>Biotic Effects</u>. Some unavoidable adverse effects on biota are: the hazards to many animals on the reservation from the traffic on the roads; the lead from automobile emissions which may accumulate in plants growing near highways, creating a hazard to herbivorous animals; and selective timber harvest which has changed the nature of the original forest.

Impacts on aquatic organisms in the streams of the reservation are significant because the concentration of some chemicals exceeds the recommended maximum limit for the protection of aquatic biota. The absence of many sensitive organisms and the abundance of pollution-tolerant species indicate degraded water quality. Efforts currently under way will improve the quality of the water and may minimize, but not eliminate, the adverse effects on aquatic life because of other pollution point sources in the area. Past operations have caused measurable concentrations of some heavy metals (e.g., mercury) in sediments of some of the tributary streams and the Clinch River, resulting in elevated levels in fish and macroinvertebrates. These effects will persist for many years.

Radiological impacts on the 735,000 persons living within 50 mi of the facilities result in minor dose increases of about 0.04 percent above natural background levels.

IV.A.3 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

The purpose of this section is to set forth the relationship between the use of man's environment implicit in the DOE operations at Oak Ridge and the actions taken to maintain and enhance the long-term productivity. One must attempt to foresee the uses of the environment by succeeding generations and consider the extent to which this present use might limit or, on the contrary, enhance the range of beneficial uses.

IV.A.3.a Enhancement of Productivity. The Y-12 facility has had a profound effect on the nation's productivity and will continue, probably even at a greater pace, to enhance this productivity in the future as the nation faces a critical energy shortage. Examples of significant advances related to present or future productivity include the following:

(1) production of nuclear weapon components as part of the national defense program;

(2) acquisition of knowledge from research efforts in the estimation of risk to man from radiation, primarily through animal studies from ORNL at Y-12;

(3) extensive medical research and development, including studies of radiation effects on biological materials, cancer research, diseases of genetic origin, virus research, the development of advanced clinical hardware, and the medical application of radioactivity for diagnostic and therapeutic applications; and

(4) because Y-12 represents 45 percent of the manufacturing payroll of Anderson County, Y-12 is an integral part of Oak Ridge's economic base.

IV.A.3.b Uses Adverse to Productivity. The local effects of operation of the Y-12 facility tend, in a small way, to oppose environmental productivity through impacts on land, water, and air. These impacts have already occurred over the more than 30 years of operation of the facilities and the trade-offs are acceptable in relation to the extensive productivity derived from the operation of the Y-12 facility.

IV.A.4 Irreversible or Irretrievable Commitments of Resources

Irreversible commitments concern changes that at some time later could not be altered so as to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent use.

Generally, land commitment is neither irretrievable nor irreversible, except possibly those tracts associated with holding ponds and burial grounds, especially burial grounds for radioactive materials. However, if the overfill of these areas is deep enough, original use of the land, in most instances, could be restored. Growth of food crops over these areas might be restricted if the fill depth was inadequate; however, fill depths should be made adequate for resumption of any natural uses of the land.

Over the past 30 years or more, no irreversible or irretrievable commitment of water resources has occurred. Some thermal, radioactive, biocidal, and chemical discharges have occurred and continue to occur, but monitoring provides adequate data on the quantities and concentrations of pollutants released to the environment. To date, the level of pollutants does not represent an environmentally hazardous situation.

As with water, no irreversible and irretrievable commitments of air resources have occurred from past operation of the Y-12 facilities. Radiological, chemical, and particulate monitoring of air continues to evaluate compliance with existing standards. Correction of the air emission problems will allow the biota to respond favorably because current particulate deposition is not a permanent impact.

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials, but numerous other mineral resources are incorporated into the Y-12 facilities. No commitments have been made as to whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly promotes recycling. The DOE operations in Oak Ridge will contaminate only a portion of the materials to such a degree that radioactive decontamination will be needed to reclaim and to recycle the constituents. The quantities of materials that cannot be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry.

Construction materials are generally expected to remain in use for the full life of a facility. A long period of time will elapse before terminal disposition must be decided. After that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of these valuable depletable resources as is practicable will depend on need.

The consumed resource materials, with the exception of uranium, have widespread usage; therefore, use of these materials in the operations must be considered reasonable with respect to needs in other industries.

Over the past 30-plus years, significant quantities of human labor resources have been irretrievably committed to the construction and operation of the Y-12 facilities. The benefits that have accrued and that continue to accrue from the operations of the Y-12 facilities fully justify the expenditure of this labor resource.

The Oak Ridge facilities have resulted in the significant land use alteration of about 5,900 acres from its original use. However, the remaining land areas of the reservation remain in a natural state, much as they were prior to Oak Ridge. A second-growth forest system and later pine plantations together cover about 80 percent of the reservation. These wooded areas provide natural habitat for many mammals and other biota, and the restricted nature of the Oak Ridge reservation has reduced hunting pressure which also enhances the survival of many species.

Although the alteration of land use has caused changes in the abundance, distribution, and location of flora and fauna within the Y-12 area, there appear to have been no irreversible or irretrievable effects on the terrestrial biota. Minor thermal, radioactive, biocidal, and chemical releases to the aquatic ecosystem have occurred and will continue. However, there is no indication that irreversible and/or irretrievable effects on the aquatic community have resulted from the construction and operation of the Y-12 facilities.

IV.A.5 Possible Conflicts Between the Proposed Action and the Objectives of Federal, State, and Local Land Use Plans, Policies, and Control

Prior to 1942, the principal land uses of the area were small-farm agriculture (pasturing cattle and hogs) and some limited tobacco and vegetable growing. Given the government acquisition of the original 56,000-acre block of land in 1942, no conflict exists at present between DOE's current use of land and local land use policies. Moreover, since DOE will most likely not need to acquire more land for expansion of its activities in the Y-12 area, there is no reason to expect any future conflict with local land use policies.

Although DOE's use of land is not in conflict with local land use policies, these local land policies are affected by the presence of the facilities. The present size and location of the Y-12 installation limits Oak Ridge's land use choices. Clearly, the reservation is land that cannot be developed privately or used by the city. Nevertheless, adequate vacant lands exist for the future growth projected by the City of Oak Ridge.

Operations at Y-12 comply with all Federal and state environmental laws, regulations, and permit requirements except for air emissions. Currently, source emissions requirements for suspended particulate matter from the steam plant are not met, however, emissions control facilities are being designed and funding for these controls is requested in the FY 1982 budget. The needed facilities are scheduled for completion in 1985.

IV.A.6 Energy Requirements and Conservation Potential

The energy consumed by Y-12 will not be increased by the proposed action. In fact, energy consumption has been decreased in recent years. Switching to coal as the primary fuel source represents a change to our most abundant fuel source.

The Y-12 personnel are constantly reviewing and evaluating operating procedures involving energy consumption. Those that have been deemed appropriate have been implemented. This approach to conservation will continue as an integral function at Y-12.

IV.B ALTERNATIVES

Improvement of environmental controls and the addition of pollution abatement equipment are the only viable alternatives. The most dramatic enhancement effect would be in air quality. The addition of baghouses to the steam generation plant would reduce particulate emissions to comply with standards. The other recommendations would reduce the potential for releasing contaminants into the surrounding environs.

IV.C LITERATURE CITED

Alexander, J. K. 1979. Background environmental information--Y-12 Plant. Report No. ORO-771. U.S. Department of Energy, Oak Ridge, TN.

Anonymous. 1969. Inorganic fluorides. Amer. Ind. Hyg. J. 30:98-101.

East Tennessee Development District. 1979. Land use plan, 1979-2000. Knoxville, TN.

Lerman, S. L. and E. F. Darley. 1975. Particulates. In: Responses of plants to air pollution. J. B. Mudd and T. T. Kozlowski (eds.), Academic Press, Inc., NY, p. 141-158.

Murakami, K. and K. Takeishi. 1977. A study of the behavior of mercury-contaminated sediments in Minamata Bay. In: Management of bottom sediments containing toxic substances. Report No. EPA-600/3-77-083, U.S. Environmental Protection Agency, Corvallis, OR.

Oak Ridge Operations. 1975. Oak Ridge land-use plan. Report No. ORO-748. U.S. Energy Research and Development Administration, Tech. Info. Center, Oak Ridge, TN.

Oak Ridge Operations. 1978. Supplement--Oak Ridge land-use plan. U.S. Department of Energy, Oak Ridge, TN.

Sanders, M. 1977. Spill prevention control and countermeasure (SPCC) plan for oil at the Oak Ridge Y-12 Plant. Report No. Y/DD-242. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

Union Carbide, 1979a. December 1978 payroll data for Y-12 Plant. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN. (letter).

Union Carbide, 1979b. Environmental monitoring report, United States Department of Energy, Oak Ridge facilities, calendar year, 1978. Report No. Y-UB-10. Nuclear Division, Union Carbide Corporation, Oak Ridge, TN.

V

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VI
APPENDICES

APPENDIX A

COPY OF Y-12 NPDES PERMIT

Permit No. TN0002968
Application No. 072-OYF-2-00297

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

United States Energy Research and Development Administration
Oak Ridge Operations

is authorized to discharge from a facility located at

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee

to receiving waters named

East Fork of Poplar Creek, Bear Creek and Clinch River

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on February 15, 1975

This permit and the authorization to discharge shall expire at midnight, February 15, 1980

Nothing in this permit shall be deemed to supersede the requirements of the Atomic Energy Act of 1954 as amended for the protection of restricted information.

Signed this 30 day of December 1974

Modification Approved

FEB 04 1977
Modification Effective Date

Regional Administrator
Date Signed FEB 04 1977

FEB 04 1977

Modification Effective Date

Modification Approved

Regional Administrator
Date Signed FEB 04 1977

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning effective date and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 001 (Kerr Hollow Quarry in Bethel Valley)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Continuous	N/A
Dissolved Solids	--	--	--	2000 mg/1	Note 1	Grab
Lithium	--	--	--	5 mg/1	Note 1	Grab
pH	--	--	--	--		Grab
Potassium	--	--	--	--	Note 1	Grab
Sodium	--	--	--	--	Note 1	Grab
Suspended Solids	--	--	--	50 mg/1	Note 1	Grab
Zirconium	--	--	--	3.0 mg/1	Note 1	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored weekly.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the total discharge prior to mixing with the receiving waters.

Note 1: Monitoring for this parameter shall be conducted following each disposal operation involving this material at a time which provides a sample representative of the discharge from this point.

2. During the period beginning effective date and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 002 (Rogers Quarry in Bethel Valley)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Discharge Limitations Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Daily(1)	N/A
Chemical Oxygen Demand			--	--	Quarterly	Grab
pH			--	--	Weekly	Grab
Settleable Solids			--	--	Weekly	Grab
Sulfate			--	--	Monthly	Grab
Suspended Solids(2)			30 mg/1	50 mg/1	Weekly	Grab
Turbidity			--	--	Weekly	Grab
Temperature					Weekly	Grab

Settleable solids shall not exceed 0.5 ml/1 during normal operations.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the total discharge prior to mixing with the receiving waters.

Note 1: Daily flow monitoring shall be initiated not later than July 1, 1975.

(continued)

2. Continued

Note 2: Suspended solids limitations shown above shall be applicable only during periods of normal operation and shall not apply during periods of increased surface runoff resulting from precipitation. Monitoring shall be conducted during such periods but shall not be included in determination of dialy average or daily maximum values.

3a. During the period beginning effective date and lasting through December 31, 1975 the permittee is authorized to discharge from outfall(s) serial number(s) 003 (New Hope Pond)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Avg	Discharge Limitations kg/day (lbs/day) Daily Max	Other Units (Specify) Daily Avg	Other Units (Specify) Daily Max	Monitoring Requirements Measurement Frequency	Monitoring Requirements Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Daily	N/A
Ammonia (N)				1.6 mg/l	Monthly	Grab
Biochemical Oxygen Demand				--	Weekly	Composite
Chemical Oxygen Demand				--	Weekly	Composite
Chromium			0.05 mg/l	0.08 mg/l	Monthly	Composite
Dissolved Oxygen(1)				--	Daily	Grab
Dissolved Solids				2000 mg/l	Monthly	Composite
Fluoride			1.5 mg/l	2.0 mg/l	Monthly	Composite
Lithium				5.0 mg/l	Quarterly	Composite
Oil and Grease			10 mg/l	15 mg/l	Monthly	Grab
pH					Daily	Grab
Phosphate (as MBAS)			5.0 mg/l	8.0 mg/l	Monthly	Composite

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):
At a point representative of the total discharge prior to mixing with the receiving waters.

(continued)

3a. Continued

During the period beginning and lasting through
the permittee is authorized to discharge from outfall(s) serial number(s)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	—	—		
Settleable Solids(2)				0.5 ml/1	Weekly	Grab
Suspended Solids(3)				20 mg/1	Weekly	Composite
Total Nitrogen (N)				20 mg/1	Monthly	Composite
Zinc			0.2 mg/1	0.3 mg/1	Weekly	Composite

Note 1: The dissolved oxygen concentration shall not be less than 5.0 mg/1.

Note 2: Settleable solids shall not exceed 0.5 ml/1 during normal operations. If the discharge volume exceeds 8.0 mgd as a result of precipitation, settleable solids shall not exceed 1.0 ml/1.

Note 3: Suspended solids concentrations shall not exceed the limitations shown during normal operations. If the discharge volume exceeds 8.0 mgd as a result of precipitation suspended solids concentrations may not exceed 100 mg/1.

Modification Approved

[signature] Deputy
Regional Administrator
Date Signed ~~FEB 04 1977~~

FEB 04 1977
Modification Effective Date

35. During the period beginning January 1, 1976 and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 003 (New Hope Pond)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Daily	N/A
Ammonia (N)				1.6 mg/l	Monthly	Grab
Biochemical Oxygen Demand				--	Weekly	Composite
Chemical Oxygen Demand				--	Weekly	Composite
Chromium			0.05 mg/l	0.08 mg/l	Monthly	Composite
Dissolved Oxygen (1)				--	Daily	Grab
Dissolved Solids				2000 mg/l	Monthly	Composite
Fluoride			1.5 mg/l	2.0 mg/l	Monthly	Composite
Lithium				5.0 mg/l	Quarterly	Composite
Oil and Grease			10 mg/l	15 mg/l	Monthly	Grab
pH					Daily	Grab
Phosphate (as MBAS)			5.0 mg/l	8.0 mg/l	Monthly	Composite

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the total discharge prior to mixing with the receiving waters.

(continued)

Modification Approved

FEB 04 1977
Modification Effective Date

Regional Administrator
Date Signed FEB 04 1977

3b. Continued

During the period beginning and lasting through
the permittee is authorized to discharge from outfall(s) serial number(s)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	--	—		
Settleable Solids(2)				0.5 ml/1	Weekly	Grab
Suspended Solids(3)				20 mg/1	Weekly	Composite
Total Nitrogen (N)				20 mg/1	Monthly	Composite
Zinc			0.1 mg/1	0.2 mg/1	Weekly	Composite

Note 1: The dissolved oxygen concentration shall not be less than 5.0 mg/1.

Note 2: Settleable solids shall not exceed 0.5 ml/1 during normal operations. If the discharge volume exceeds 8.0 mgd as a result of precipitation, settleable solids shall not exceed 1.0 ml/1.

Note 3: Suspended solids concentrations shall not exceed the limitations shown during normal operations. If the discharge volume exceeds 8.0 mgd as a result of precipitation, suspended solids concentrations may not exceed 100 mg/1.

Modification Approved

Regional Administrator
Date Signed ~~FEB 04 1977~~

FEB 04 1977
Modification Effective Date

4b. During the period beginning July 1, 1977 and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 004 (Bear Creek)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations (1) kg/day (lbs/day) Daily Avg	Discharge Limitations (1) kg/day (lbs/day) Daily Max	Discharge Limitations (1) Other Units (Specify) Daily Avg	Discharge Limitations (1) Other Units (Specify) Daily Max	Monitoring Requirements Measurement Frequency	Monitoring Requirements Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Daily	N/A
Aluminum					Weekly	Composite
Biochemical Oxygen Demand (5 Day)					Weekly	Composite
Chemical Oxygen Demand					Monthly	Composite
Conductivity					Weekly	Grab
Dissolved Oxygen					Daily	Grab
Dissolved Solids					Weekly	Composite
Nitrate (N)					Weekly	Composite
Oil and Grease			10 mg/l	15 mg/l	Quarterly	Grab
pH					Weekly	Grab
Suspended Solids					Weekly	Composite
Turbidity					Weekly	Grab

The pH shall not be less than 6.0 standard units nor greater than 8.5 standard units and shall be monitored

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s)
At the intersection of Bear Creek and Highway 95.

Modification Approved

FEB 04 1977
Modification Effective Date

for [signature], Deputy
Regional Administrator

FEB 04 1977
Date Signed

Note 2: The permittee shall maintain and make available for inspections, records of the date of each disposal operation and the type and amount of each material disposed of. A summary of the number of disposal operations and total quantities of each material shall be included with the monitoring report for their discharge.

4a. During the period beginning effective date and lasting through June 30, 1977 the permittee is authorized to discharge from outfall(s) serial number(s) 004 (Bear Creek)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)		Other Units (Specify)		Monitoring Requirements	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	—	—	Daily	N/A
Aluminum					Weekly	Grab
Biochemical Oxygen Demand (5 Day)					Weekly	Grab
Chemical Oxygen Demand					Monthly	Composite
Conductivity					Weekly	Grab
Dissolved Oxygen					Daily	Grab
Dissolved Solids					Weekly	Grab
Nitrate (N)					Weekly	Grab
Oil and Grease			10 mg/l	15 mg/l	Quarterly	Grab
pH					Weekly	Grab
Suspended Solids					Weekly	Composite
Turbidity					Weekly	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):
At the intersection of Bear Creek and Highway 95.

4b. Continued

Note 1: Final discharge limitations on the parameters aluminum, dissolved oxygen and nitrate (as N) shall be established by the Regional Administrator after review of the data to be submitted by the permittee in accordance with the requirements of Part I. B., "Schedule of Compliance" and consultation with the State of Tennessee, Department of Public Health, Division of Water Quality Control. Not less than 30 days prior to establishment of final discharge limitations, the Regional Administrator shall make public notice of intent to establish such limitations and shall provide an opportunity for hearing.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

   a. Discharge 003 (New Hope Pond)

      (1) Submit by June 30, 1975, an engineering study and cost estimate for the reduction of the daily maximum zinc concentration to 0.1 mg/l by the elimination of the addition of a zinc based corrosion inhibitor to the intake water at the Oak Ridge Water Treatment Plant.

      (2) Achieve compliance with final limitations - January 1, 1976

   b. Discharge 004 (Bear Creek)

      (1) Submit by December 31, 1975, a feasibility study and cost estimate for the achievement of the following discharge limitations in Bear Creek.

Parameter	Daily Maximum
Aluminum	1.0 mg/l
Nitrate (N)	20 mg/l

Dissolved oxygen concentration not less than 5.0 mg/l.

      (2) Complete plans - March 30, 1976

      (3) Submit interim report - December 31, 1976

      (4) Achieve compliance with final limitations - July 1, 1977

2. No later than 14 calendar days following a data identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions take and the probability of meeting the next scheduled requirement.

APPENDIX B

COMMON - SCIENTIFIC SPECIES NAMES

APPENDIX B

FLORA[a]

Common Name	Scientific Name
American chestnut	*Castanea dentata*
Northern red oak	*Quercus borealis*
Chestnut oak	*Q. prinus*
Yellow poplar	*Liriodendron tulipifera*
Shortleaf pine	*Pinus echinata*
Virginia pine	*P. virginiana*
Beech	*Fagus grandifolia*
Sugar maple	*Acer rubrum*
Magnolia	*Magnolia acuminata* and *M. tripetala*
Buckeye	*Aesculus glabra*
Willow	*Salix* sp.
Sycamore	*Platanus occidentalis*
Boxelder	*Acer negundo*
Loblolly pine	*Pinus taeda*
Hickory	*Carya* sp.
Hemlock	*Tsuga canadensis*
White pine	*Pinus strobus*
Eastern red cedar	*Juniperus virginianus*
Redbud	*Cercis canadensis*
Sassafras	*Sassafras albidum*

(a) Nomenclature and taxonomy follow the interpretation of Fernald (1950).

Common Name	Scientific Name
Cottonwood	*Populus deltoides*
Elm	*Ulmus* sp.
Ash	*Fraxinus* sp.
Silver maple	*Acer saccharinum*
River birch	*Betula nigra*
White oak	*Quercus alba*
Black oak	*Q. velutina*
Scarlet oak	*Q. coccinea*
Post oak	*Q. stellata*
Black gum	*Nyssa sylvatica*
Dogwood	*Cornus florida*
Basswood	*Tilia americana*
Bluestem	*Adropogon* sp.
Bluegrass	*Poa* sp.
Orchard grass	*Dactylis glomerata*
Ragweed	*Ambrosia artemisifolia*
Crabgrass	*Digitaria* sp.
Horseweed	*Conyza canadensis*
Primrose	*Oenothera* sp.
Honeysuckle	*Lonicera japonica*
Broomsedge	*Andropogon virginicus*
Trumpet creeper	*Campsis radicans*
Sumac	*Rhus typhina* and *R. copallina*
Persimmon	*Diospyros virginiana*
White poplar	*Populus alba*
Watercress	*Nasrtium* sp.

Common Name	Scientific Name
Cattail	*Typha* sp.

MAMMALS[b]

Common Name	Scientific Name
Virginia oppossum	*Didelphis virginiana*
Southeastern shrew	*Sorex longirostris*
Short-tailed shrew	*Blarina breyicauda*
Southern short-tailed shrew	*B. carolinensis*
Gray myotis	*Myotis grisescens*
Indiana myotis	*M. sodalis*
Eastern cottontail	*Sylvilagus floridanus*
Eastern chipmunk	*Tamias striatus*
Gray squirrel	*Sciurus carolinensis*
Fox squirrel	*S. niger*
Marsh rice rat	*Oryzomys palustris*
White-footed mouse	*Peromyscus leucopus*
Cotton mouse	*P. gossypinus*
Golden mouse	*Ochrotomys nuttali*
Woodland (Pine) vole	*Microfus pinetorum*
Red fox	*Vulpes vulpes*
Gray fox	*Urocyon cinereoargenteus*
Black bear	*Ursus americanus*

(b) Nomenclature and taxonomy follows the interpretation of Jones et al. (1973).

Common Name	Scientific Name
Raccoon	*Procyon lotor*
Long-tailed weasel	*Mustela frenata*
Mountain lion (eastern cougar)	*Felis concolor*
Bobcat	*Lynx rufus*
White-tailed deer	*Odocoileus virginianus*

BIRDS[c]

Common Name	Scientific Name
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*A. cooperii*
Red-shouldered hawk	*Buteo lineatus*
Broad-winged hawk	*B. playtpterus*
Southern bald eagle	*Haliaeetus l. leucocephalus*
Marsh hawk	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Ruffed grouse	*Bonasa umbellus*
Bobwhite	*Colinus virginianus*
Turkey	*Meleagris gallopavo*
Mourning dove	*Zenaida macroura*
Common (yellow-shafted) flicker	*Colaptes auratus*

(c) Nomenclature and taxonomy follows the interpretation of Wetmore (1957) and Eisenmann (1973, 1976).

Common Name	Scientific Name
Red-bellied woodpecker	*Melanerpes carolinus*
Hairy woodpecker	*Picoides villosus*
Downy woodpecker	*P. pubescens*
Red-cockaded woodpecker	*P. borealis*
Blue jay	*Cyanocitta cristata*
Common crow	*Corvus brachyrhynchos*
Carolina chickadee	*Parus carolinensis*
Tuffed titmouse	*P. bicolor*
Bewick's wren	*Thryomanes bewickii*
Wood thrush	*Hylocichla mustelina*
Red-eyed vireo	*Vireo olivaceus*
Pine warbler	*Dendroica pinus*
Ovenbird	*Seiurus aurocapillus*
Kentucky warbler	*Oporornis formosus*
Yellow-breasted chat	*Icteria virens*
Scarlet tanager	*Piranga olivacea*
Summer tanager	*P. rubra*
Cardinal	*Cardinalis cardinalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Grasshopper sparrow	*Ammodramus savannarum*
Bachman's sparrow	*Aimophila aestivalis*
White-throated sparrow	*Zonotrichia albicollis*

REPTILES AND AMPHIBIANS[d]

Common Name	Scientific Name
American toad	*Bufo americanus*
Fowler's toad	*B. woodhousei*
Hellbender	*Cryptobranchus alleganiensis*
Northern dusky salmander	*Desmognathus fuscus*
Red-spotted newt	*Notophthalmus viridescens*
Tennessee cave salamander	*Gyrinophilus palleucus*
Mudpuppy	*Necturus maculosus*
Red-backed salamander	*Plethodon cinereus*
Slimy salamander	*P. glutinosus*
Northern red salamander	*Pseudotriton r. ruber*
Snapping turtle	*Chelydra serpentina*
Map turtle	*Graptemys geographica*
River cooter (slider)	*Chrysemys concinna*
Yellow-bellied turtle	*C. scripta*
Eastern box turtle	*Terrapene carolina*
Northern copperhead	*Agkistrodon contortrix mokasen*
Six-lined racerunner	*Cnemidophorus sexlineatus*
Northern black racer	*Coluber constrictor*
Timber rattlesnake	*Crotalus h. horridus*
Black rat snake	*Elaphe obsoleta*

(d) Nomenclature and taxonomy follows the interpretation of Conant (1975).

Common Name	Scientific Name
Five-lined skink	*Eumeces fasciatus*
Eastern hognose snake	*Heterodon platyrhinos*
Northern water snake	*Natrix s. sipedon*
Fence lizard	*Sceloporus undulatus*
Northern brown snake	*Storeria d. dekayi*
Eastern garter snake	*Thamnophis s. sirtalis*

FISH[d]

Common Name	Scientific Name
Rock bass	*Ambloplites rupestris*
Common shiner	*Notropis cornutus*
White sucker	*Catostomus commersoni*

(d) Nomenclature and taxonomy follows the interpretation of Trautman (1957).

LITERATURE CITED

Conant, R. 1975. A field guide to reptiles and amphibians of Eastern and Central North America. Houghton Mifflin Company, Boston. 429 pp.

Eisenmann, E. chmn., Committee on Classification and Nomenclature. 1973. Thirty-second supplement to the American Ornithologists' Union checklist of North American birds. The Auk 90(2):411-419.

Eisenmann, E. chmn., Committee on Classification and Nomenclature. 1976. Thirty-third supplement to the American Ornithologists' Union checklist of North American birds. The Auk 93:875-879.

Fernald, M. L. 1950. Gray's manual of botany. 8th ed. American Book Co., New York, N.Y.

Jones, J. K., Jr., D. C. Carter, and H. H. Genoways. 1973. Checklist of North American mammals north of Mexico. Occ. Pap. Mus. Texas Tech. Univ. No. 12. 14 pp.

Trautman, M. B. 1957. The fishes of Ohio. Ohio State Univ. Press. Columbus, Oh.

Wetmore, A. chmn., Committee on Classification and Nomenclature. 1957. Checklist of North Amercian birds, 5th ed. American Ornithologists' Union, Washington, D.C.

APPENDIX C

CORRESPONDENCE

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424
Telex 24-5454

October 9, 1979

Mr. John Hafner
Wetlands Coordinator - Region IV
U.S. Fish and Wildlife Service
75 Spring S.W.
Atlanta, Georgia 30303

Dear John:

Wetland Sites in Oak Ridge, Tennessee

As you are aware from our previous telephone conversations, Battelle's Columbus Laboratory is currently involved in an environmental assessment for Union Carbide's Y-12 Plant in Oak Ridge, Tennessee. The plant is located on the DOE Reservation adjacent to the city. Y-12 occupies approximately 850 acres of industrial complex and 2,570 acres of buffer area. This land is situated in Bear Creek Valley.

Please advise as to any wetlands identified by your national inventory in the vicinity of Oak Ridge, Tennessee.

Your cooperation in this matter is greatly appreciated, and your prompt attention to this request will expedite our final report.

Sincerely,

Frederick L. Moleski, Ph.D.
Research Scientist
Ecology and Ecosystems
Analysis Section

FLM:rjc

United States Department of the Interior
FISH AND WILDLIFE SERVICE
75 SPRING STREET, S.W.
ATLANTA, GEORGIA 30303

October 26, 1979

Dr. Frederick L. Moleski
Research Scientist
Ecology and Ecosystems Analysis
Section
Battelle, Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

Dear Dr. Moleski:

The National Wetland Inventory has not undertaken any mapping activities in the Oak Ridge, Tennessee, area. Therefore, we are unable at this time to provide you with wetland data specific to the environmental assessment for the Union Carbide Y-12 Plant.

Hopefully, we will be more helpful to you as your environmental studies take place in other areas.

Sincerely yours,

John M. Hefner

John M. Hefner
Regional Wetlands Coordinator

APPENDIX D

CONSULTANTS

APPENDIX D

Faust, Lucien - City Planner
City of Oak Ridge Planning Commission
Oak Ridge, Tennessee

Hafner, John - Wetlands Coordination
U.S. Fish and Wildlife Service
Region IV
Atlanta, Georgia

Hauptman, Jack - Specialist Scenic Rivers
Division of Water Resources
DOI/Heritage Council
Washington, D.C.

Keck, Lee - Water Resources Planner
Division of Water Resources
Tennessee Department of Conservation
Nashville, Tennessee

Nelson, Marque - Division Chief
National Wildlife Refugee System
DOI/U.S. Fish and Wildlife Service
Washington, D.C.

Sims, Sam R. - Soil Scientist
U.S.D.A. Soil Conservation Service
Nashville, Tennessee

Styke, Quincy N., III - Air Quality Specialist
Air Pollution Control Division
Tennessee Department of Public Health
Knoxville, Tennessee

Tremblay, Richard - Senior Program Planner
East Tennessee Development District
Knoxville, Tennessee

Van Wienkle, Webb - Aquatic Biologist
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Webb, Al - District Conservationist
U.S.D.A. Soil Conservation Service
Clinton, Tennessee